



From Weeks to Seconds: Scaling Network Operations with Kubernetes Operators

9.9.2025, Adrian Kurt, Alessio Diamanti

Container Days 2025



swisscom



Talk Series of our Cloud Native Transformation

**How We Are Moving from
GitOps to Kubernetes
Resource Model in 5G Core**

KubeCon Europe

2024

**Kubenet: Harnessing
Kubernetes for Network
Automation**

Cloud Native Telco Day

2025

**Enterprise-grade
Infrastructure as a Service in a
Cloud Native Way**

Cloud Native Zurich

2025

2024

**Building and Operating a
Highly Reliable Cloud Native
DNS Service With Open-Source
Technologies**

Container Days Conference

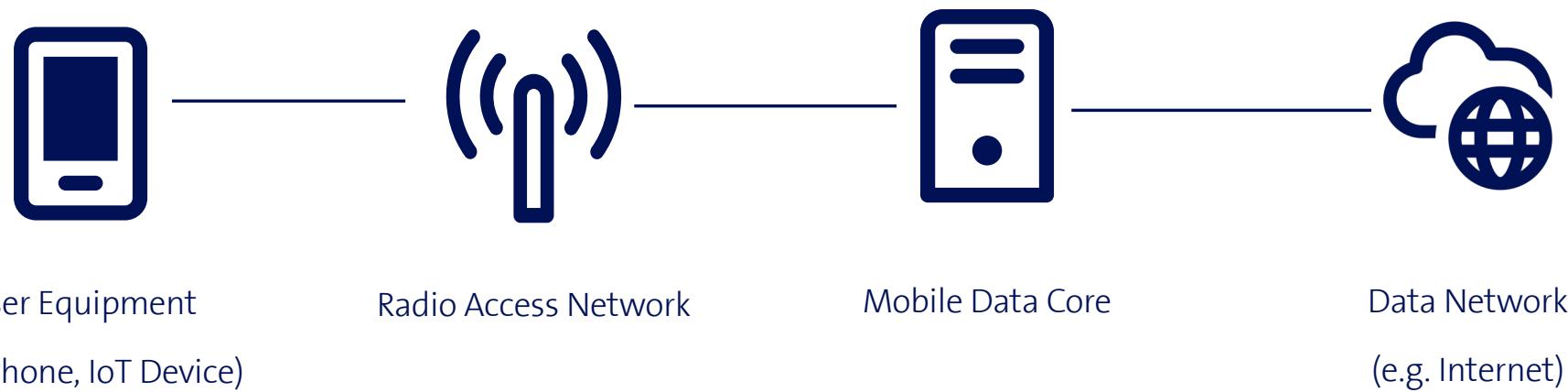
2025

**Keynote: Cloud Native
Evolution in Telecom: 5G, 6G
and Beyond!**

KubeCon + CloudNativeCon
Europe

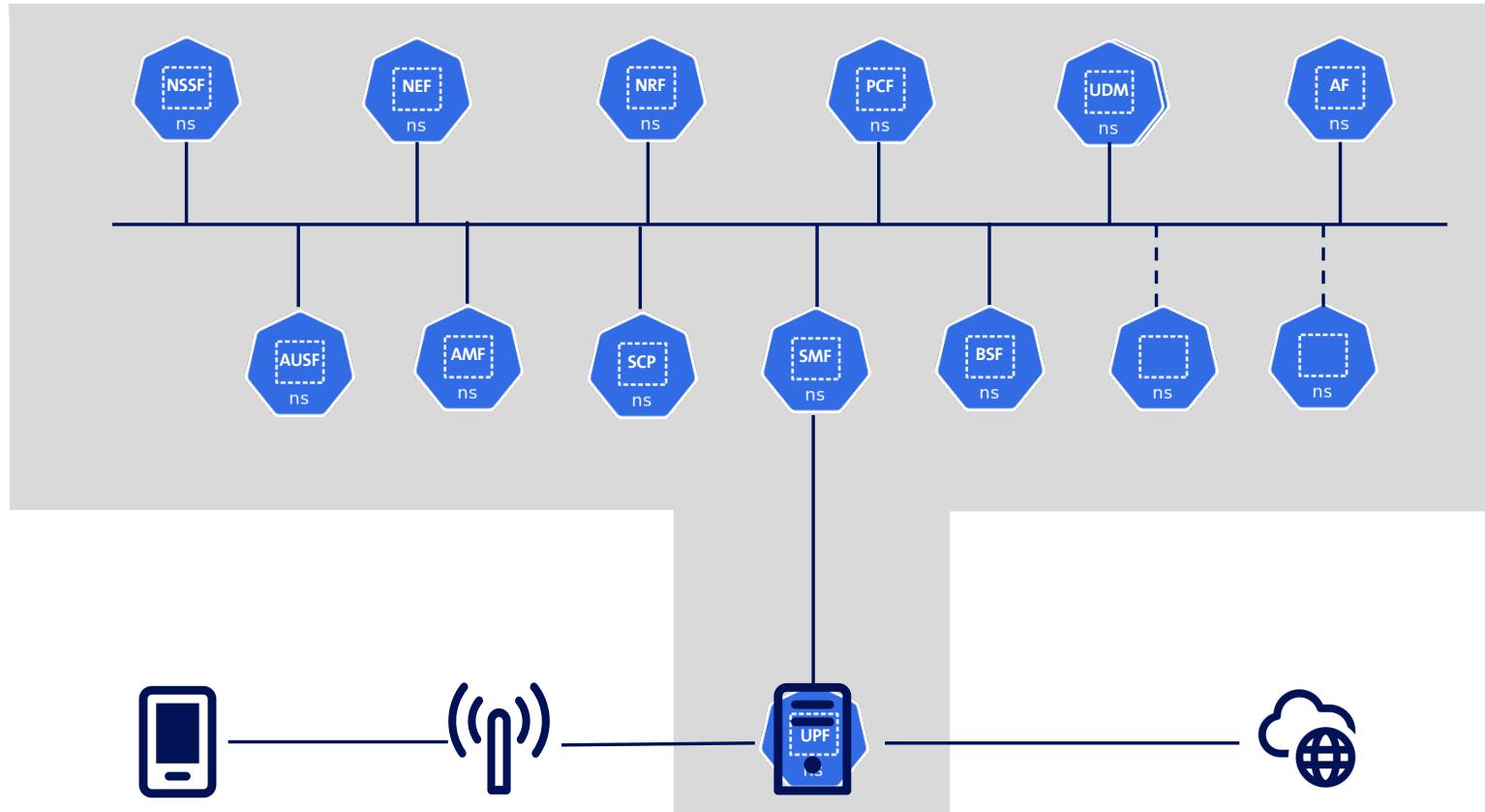


Mobile Data Core Network: Simplified View (1/2)





Mobile Data Core Network: Simplified View (2/2)





The Mobile Network Complexity (1/2)

Each blue object

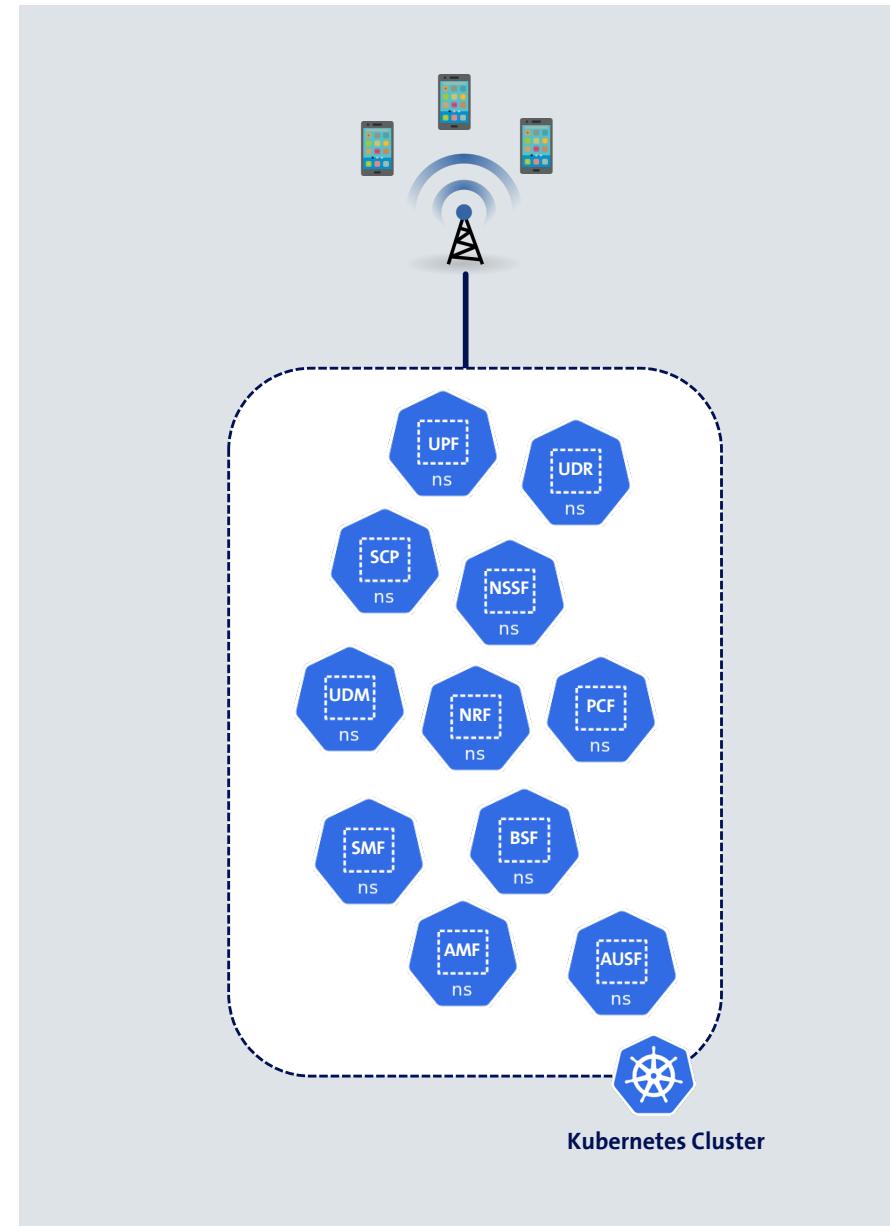
- is a Containerized Network Function (CNF)
 - e.g. Router (UPF), Session Management (SMF)
- Deployed using Helm

Configuration is done via

- Helm Values
- Other Configuration Interfaces
 - NETCONF, REST API

Scale

- A development environment contains ~ 2000 pods
- A total of **5000 interdependent configuration parameters**



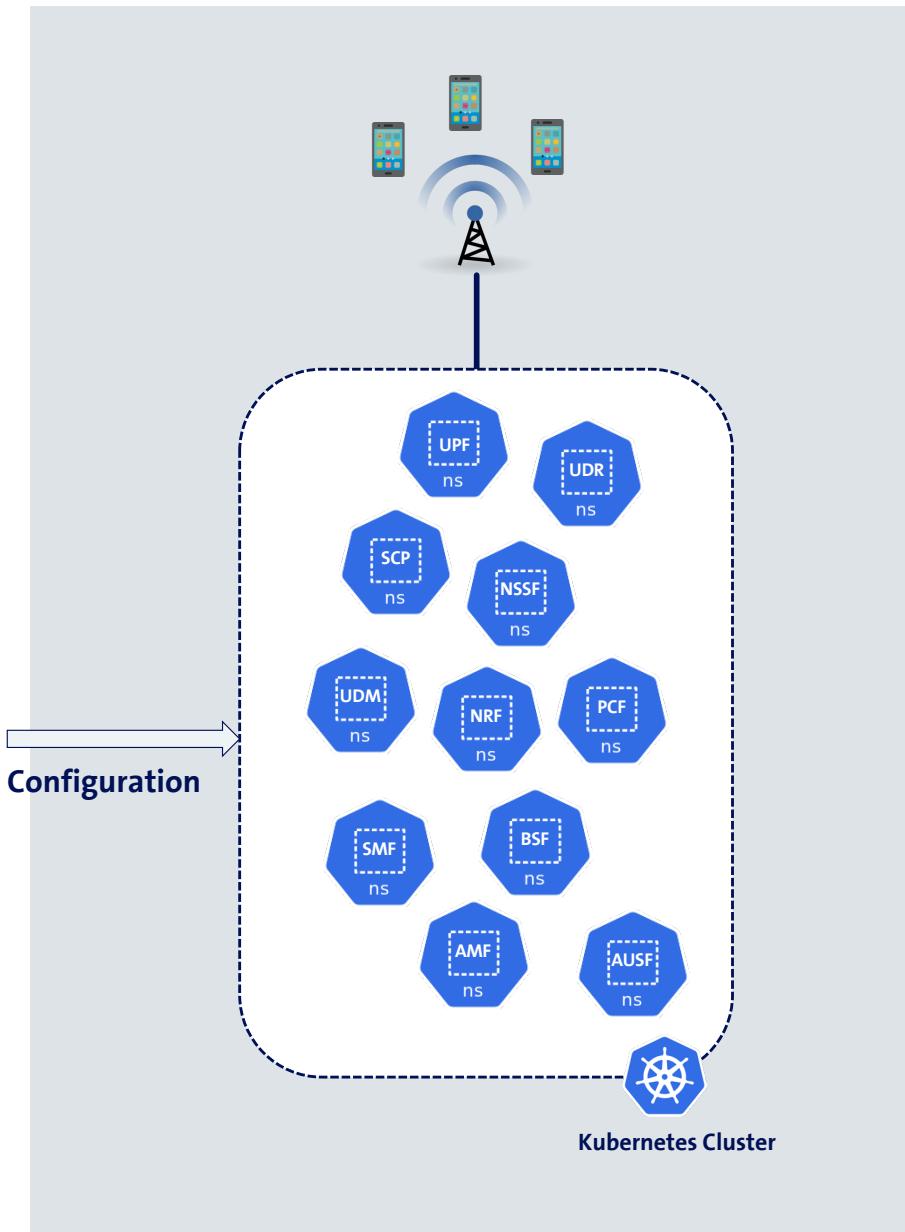


The Mobile Network Complexity (2/2)

Some of the 5000 interdependent configuration parameters:

- IP addresses
- Subnets
- VLANs
- DNS Records
- Network function variables
- Infrastructure variables
- Network function-Network function mapping
- Secret references
- Certificate references

```
YAML configuration file showing complex interdependent parameters. The file contains numerous sections and variables, including:  
- Network functions: UPF, UDR, SCP, NSSF, UDM, NRF, PCF, SMF, BSF, AMF, AUSF.  
- Infrastructure: IP addresses, subnets, VLANs, DNS records.  
- Variables: Network function variables, infrastructure variables.  
- Mappings: Network function-Network function mapping.  
- References: Secret and certificate references.  
The code is highly nested and interconnected, reflecting the complexity of the configuration.
```

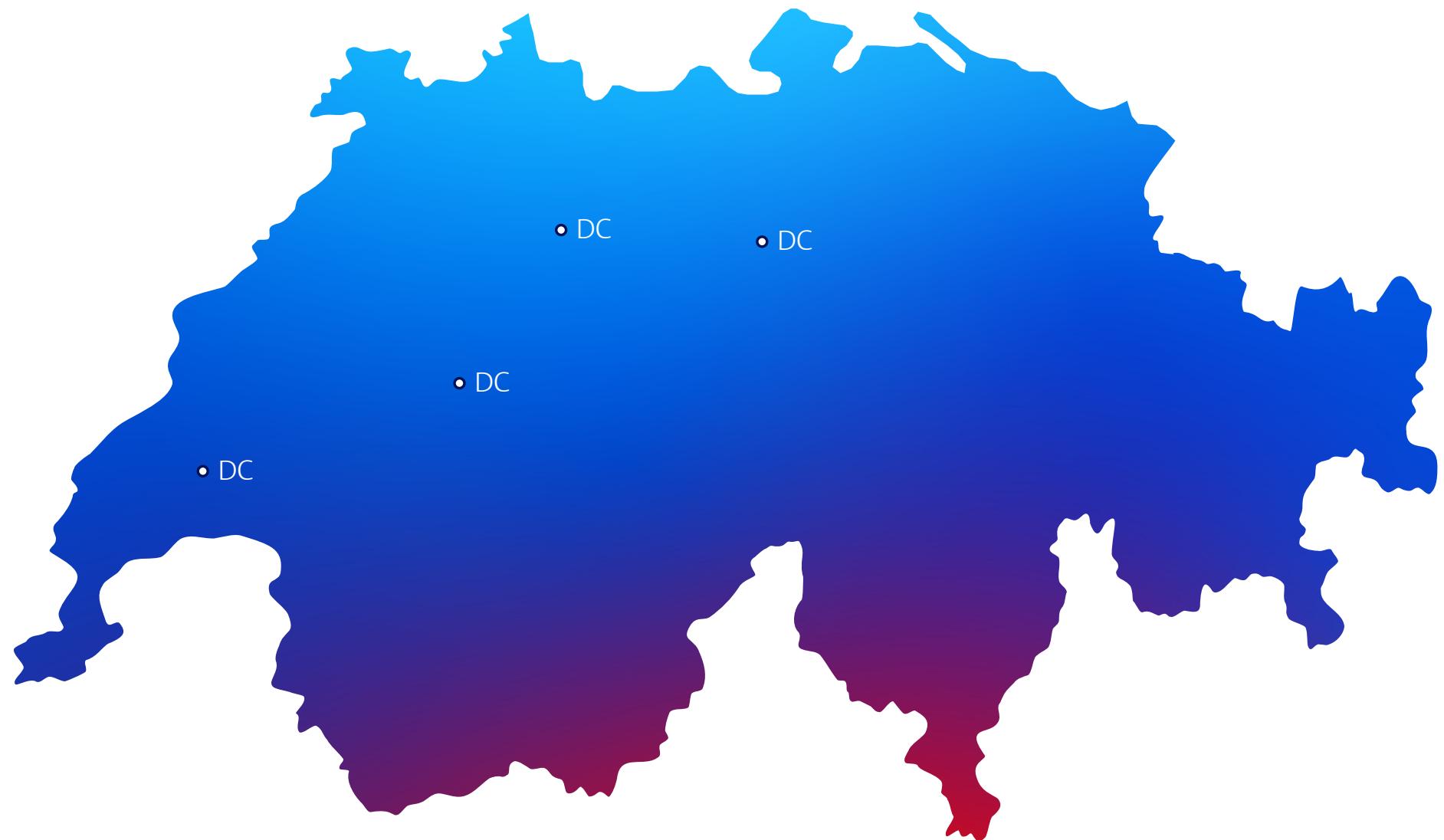




Configuration



Thousands of parameters must always be
in sync.





Configuration



Thousands of parameters must always be in sync.

Scale



Mobile Data Core is deployed in many data centers.

Closed Ecosystem



Vendors sell proprietary tools with their software.



Swisscoms Approach



Configuration



Intent driven automation

Scale



GitOps and Kubernetes Operators

Closed Ecosystem



Open Source and CNCF ecosystem



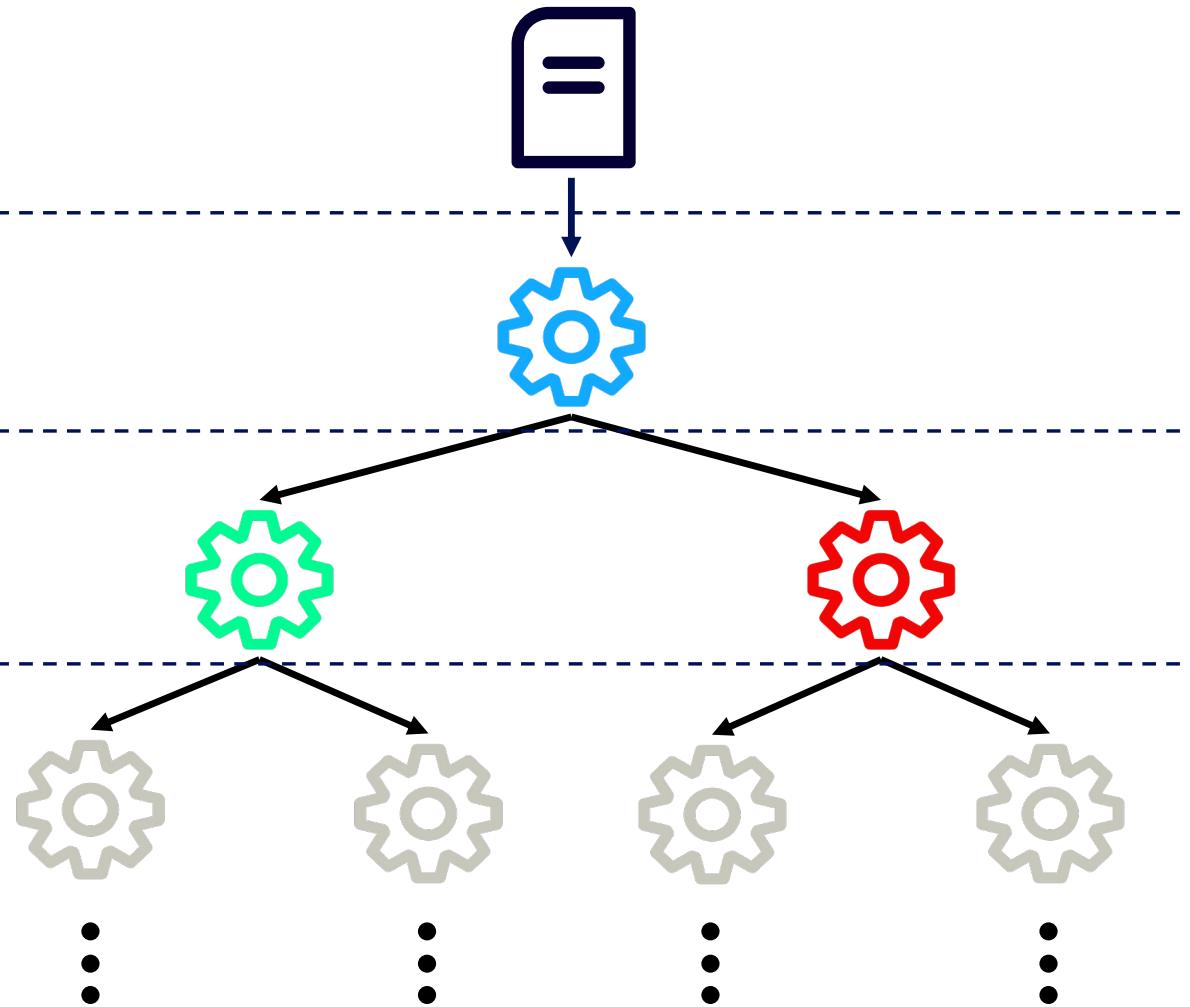
Layered Kubernetes Operators

High level intent

First Level Operator

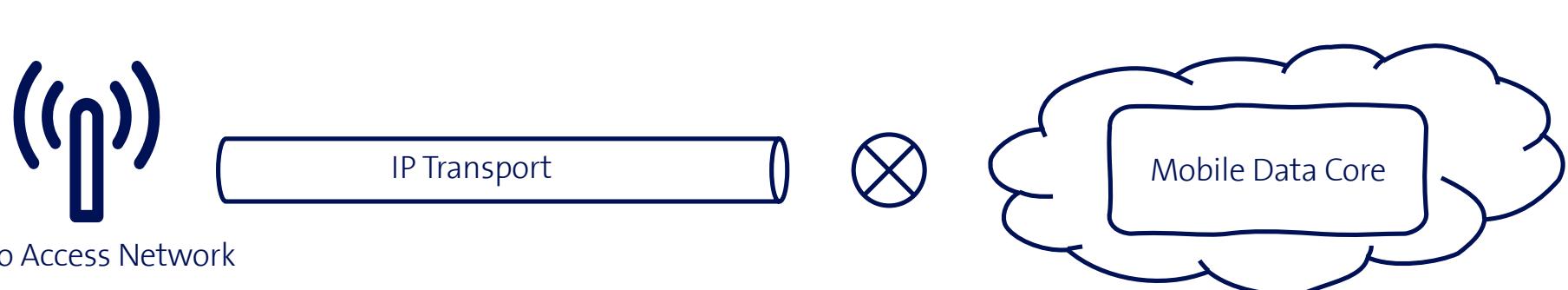
Second Level Operators

Third Level Operators





An Example of Connectivity Automation

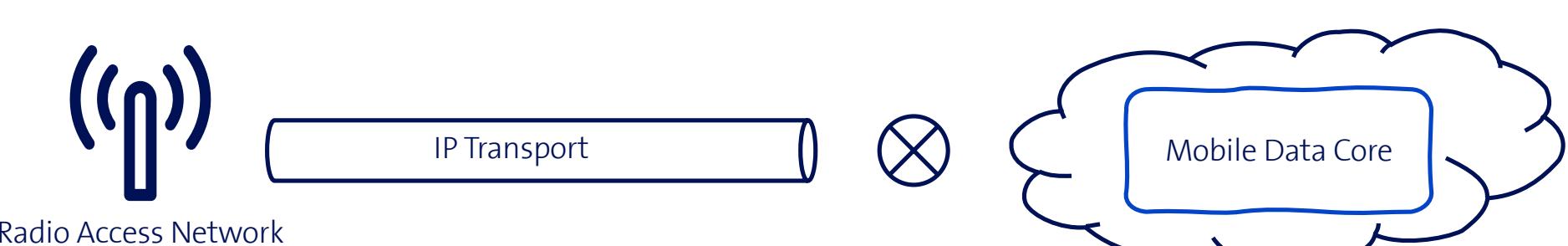




An Example of Connectivity Automation

We need:

- IP addresses

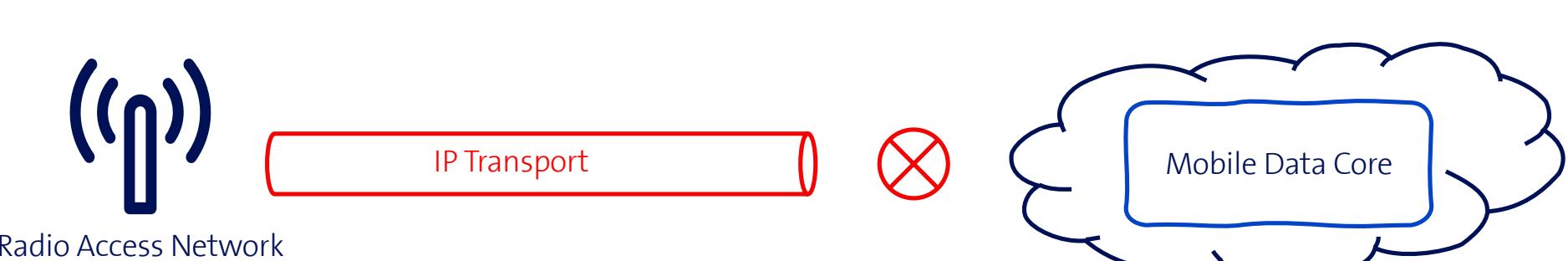




An Example of Connectivity Automation

We need:

- IP addresses
- IP Transport configuration

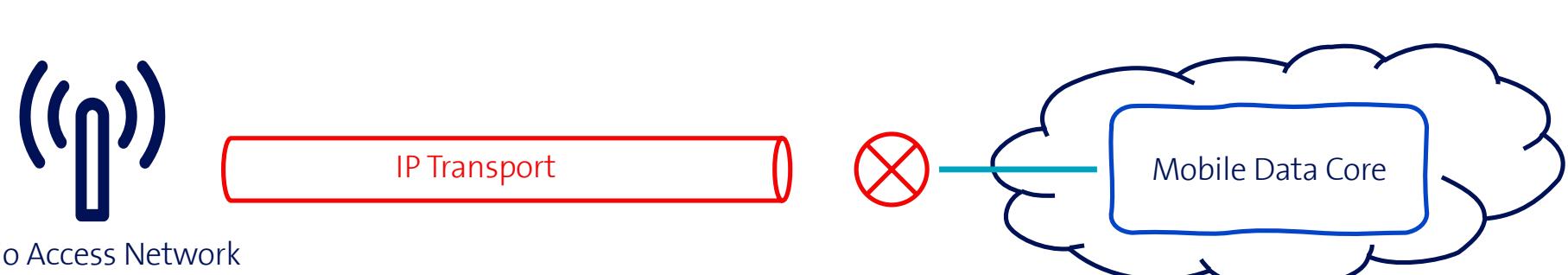




An Example of Connectivity Automation

We need:

- IP addresses
- IP Transport configuration
- Workload configuration



Radio Access Network



What is needed to run a 5G-Core?



IPAM

Prefix and IP address management system



Routing

Routing traffic to our services and back



Configuration of Network Core

Generate configuration for our workloads and apply them



NetBox

NetBox is the network source of truth used for IPAM and DCIM
netboxlabs.com/docs/netbox



MetalLB & Network-as-a-Service

Load balancing and router management
metallb.io

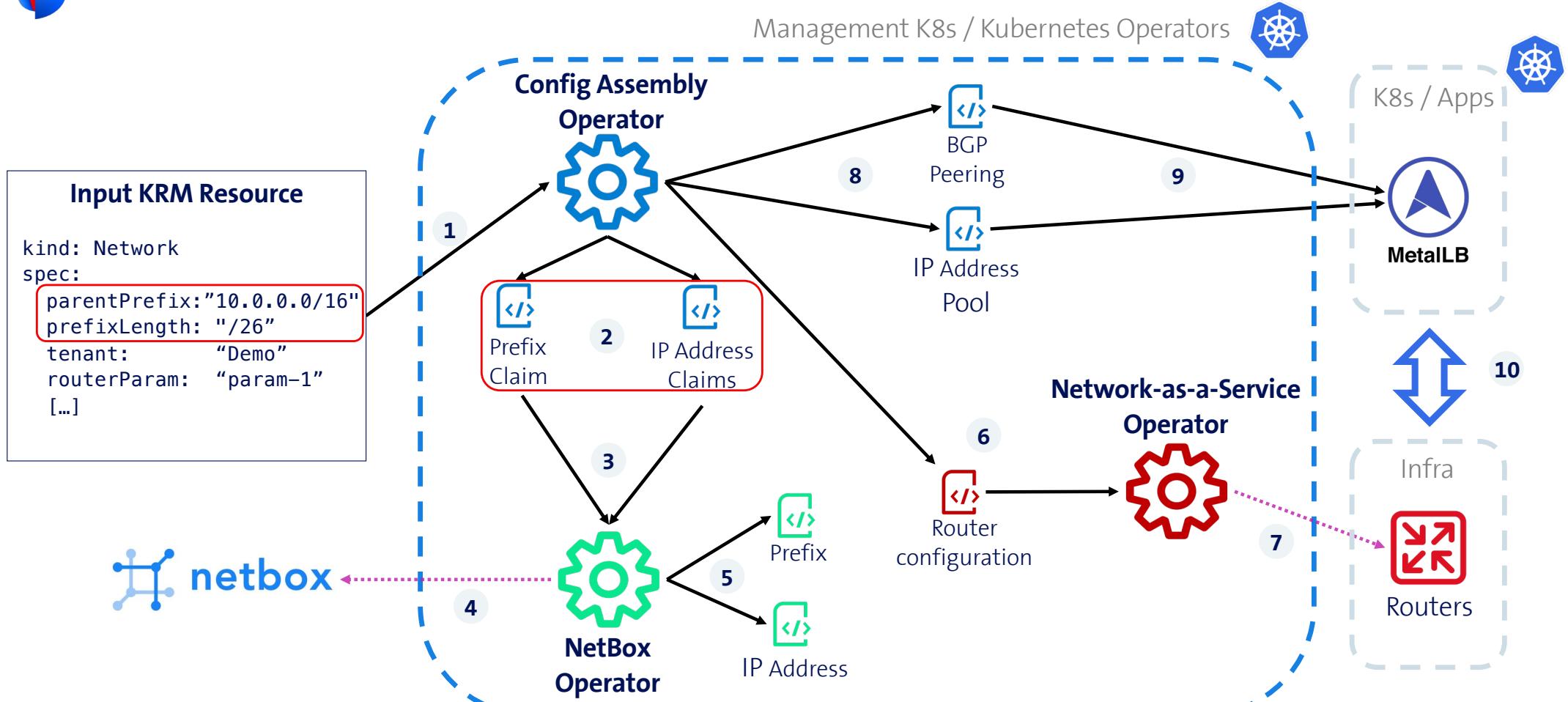


SDCIO

Cloud Native based Schema Driven Configuration
docs.sdcio.dev



Connectivity Configuration through Kubernetes Operators



A wide-angle photograph of a majestic mountain range during sunset or sunrise. The sky is a gradient of warm orange and red hues. The mountains in the foreground are dark and silhouetted, while those in the background are bathed in the warm light of the setting sun, showing rugged peaks and deep valleys. A dark, semi-transparent rectangular overlay covers the bottom half of the image. Inside this overlay, the word "Demo" is written in a large, white, sans-serif font.

Demo



Kubernetes Operators Technical Benefits



KRM Based

Input and Output in Kubernetes
Resource Model (KRM) format



Gradual Adoption

Migration to operators
taken at own pace.



Output Flexibility

Generated resources stored with
various backends

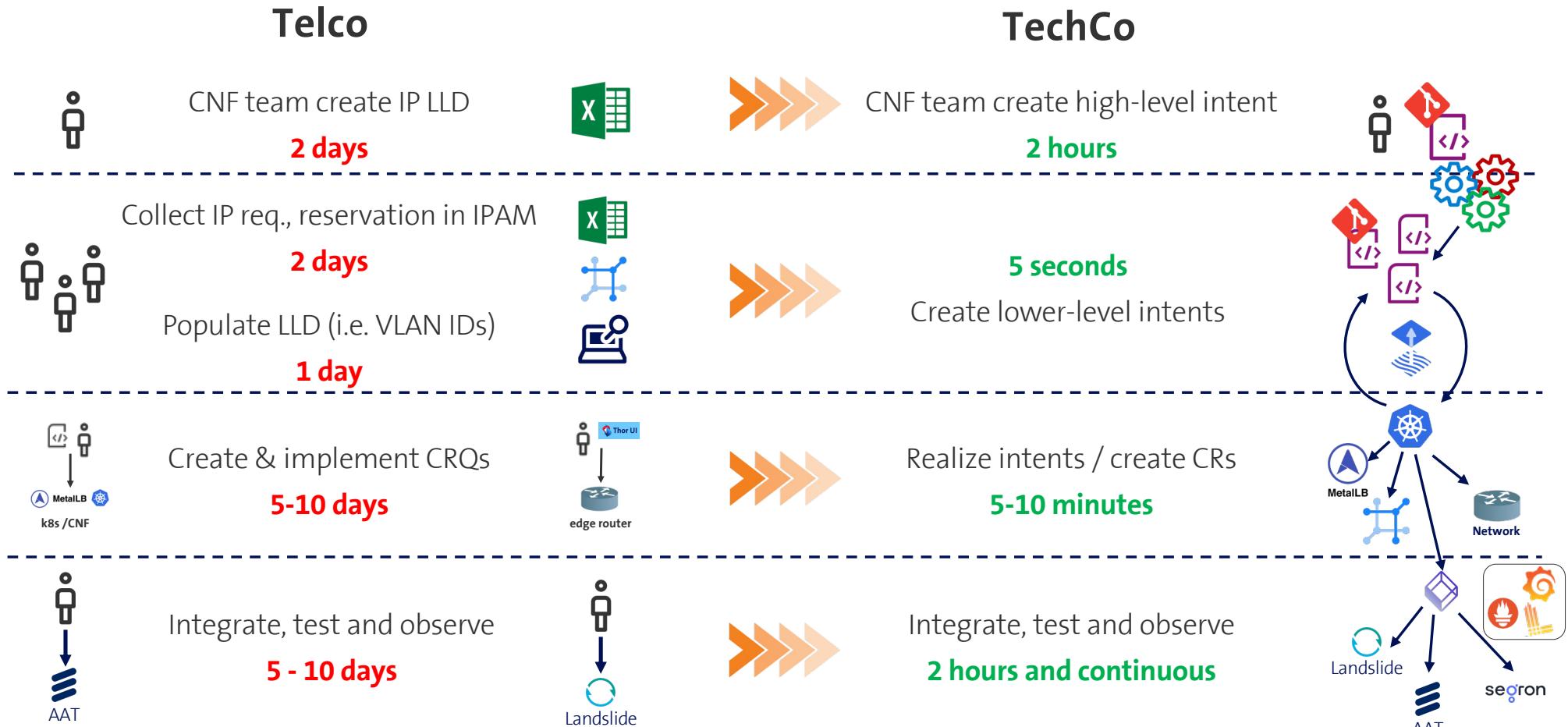


Reconciliation

Output is updated/deleted as
Input is changed/deleted

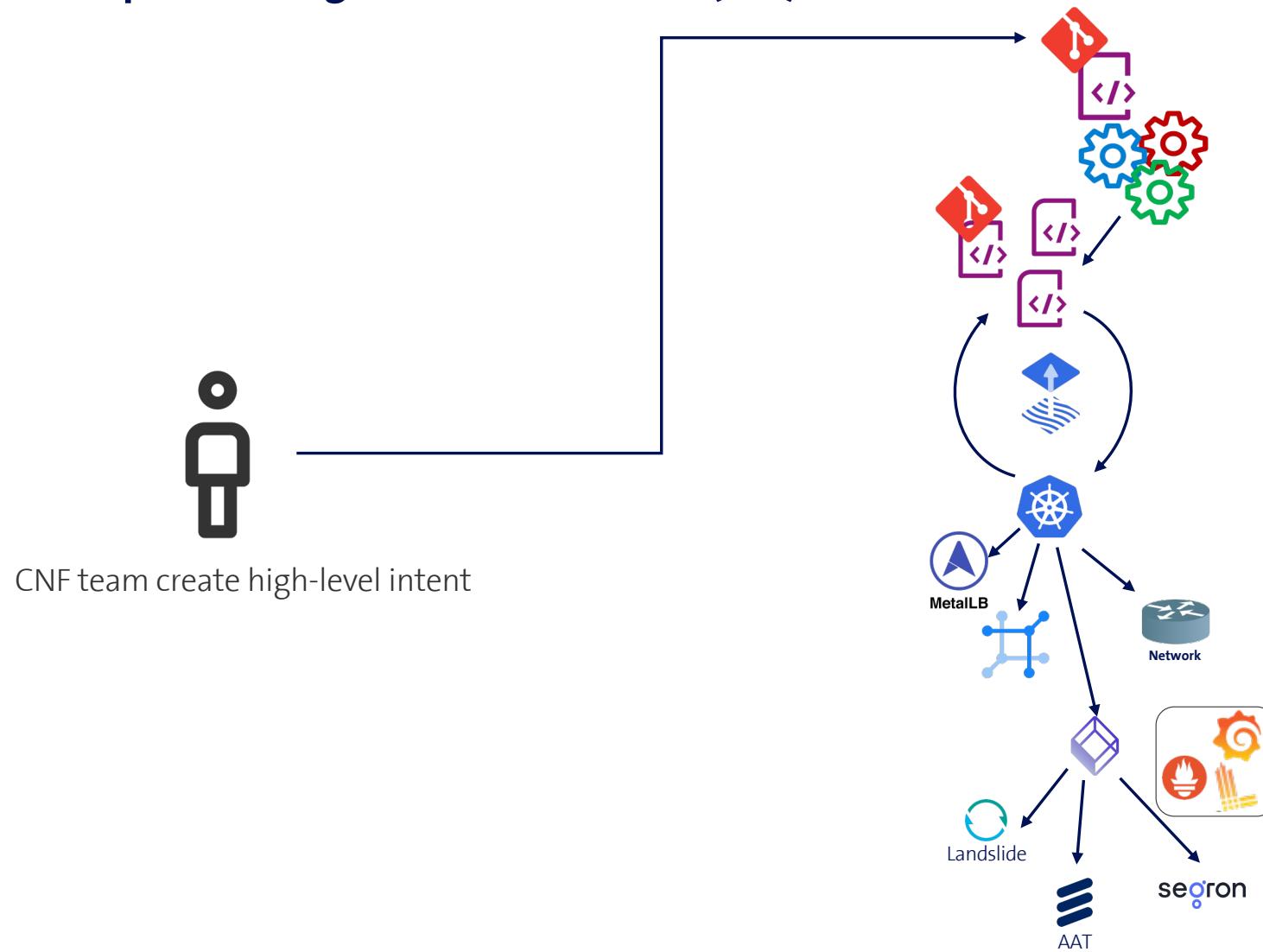


Kubernetes Operators Organisational Benefits (1/2)





Kubernetes Operators Organisational Benefits (2/2)





Our Learnings & Suggestions

on network automation using Operators





Avoid

Building “all-in-one” operators
implementing all your business logic

Complicated configurations
Avoid unnecessary layers of abstraction and overengineer
your Kubernetes operators

Neglect Industry Relevance
Don’t assume KRM challenges and solutions are unique to
your sector/industry





Aim to

Decouple & Chain

Leverage specialized operators and chain them

Leverage abstraction

Simplify complex configurations by focusing on essential controls

Use frameworks

Build your operator using frameworks such a Kubebuilder to concentrate on your business logic

Contribute to the ecosystem

Share your code



Just Claim It: Simplifying Network Automation with NetBox Operator

Wed 16:00 - 16:35

Stage K1



Lea Brühwiler

SEP 09 – 11, 2025
CONTAINER
days
CONFERENCE



The Cloud-Native Advantage: Intent-based Network Automation

Wed 17:30 - 18:05

Stage K6



Alexander North

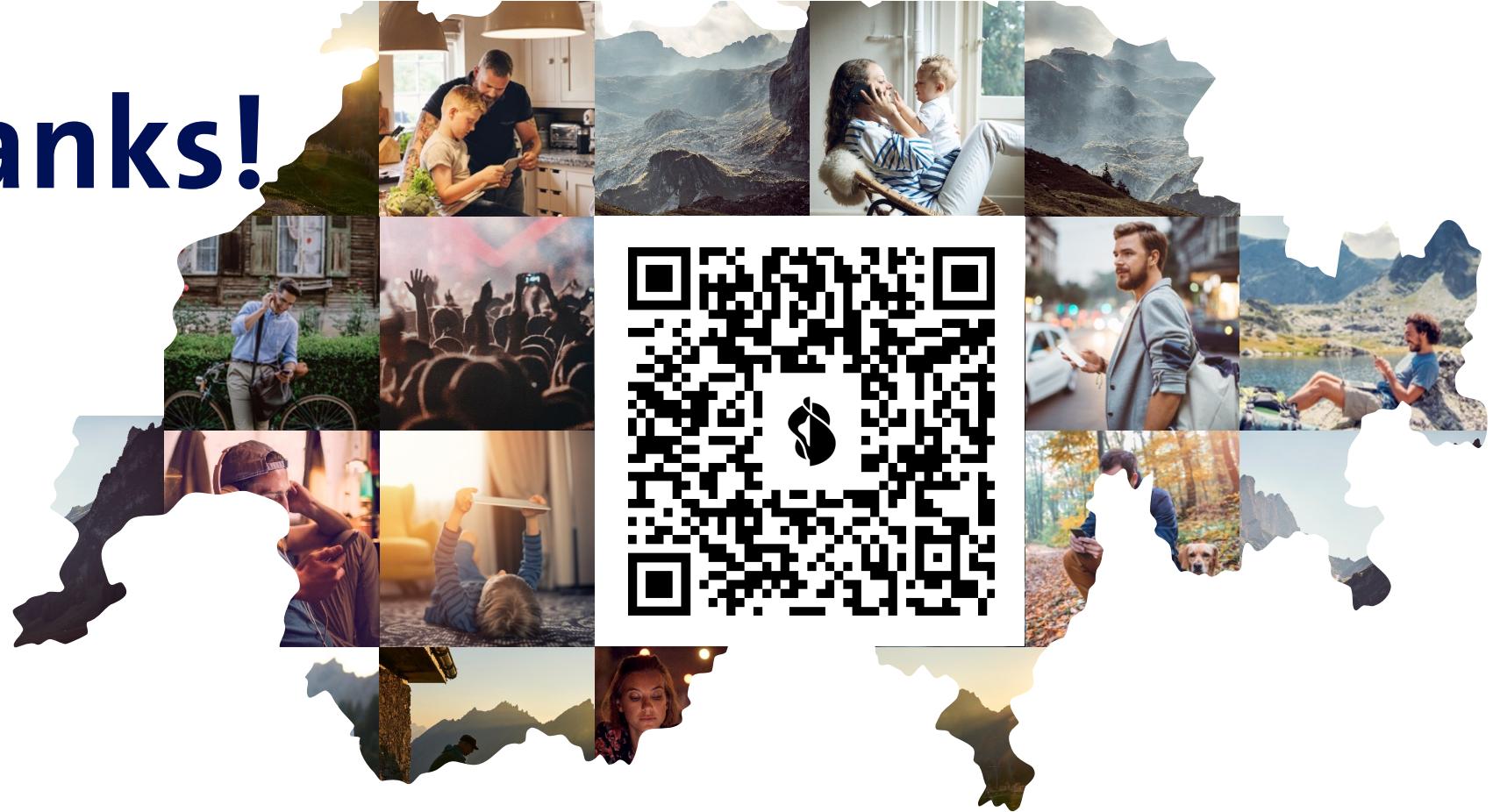


Markus Vahlenkamp

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Thanks!





Q&A

