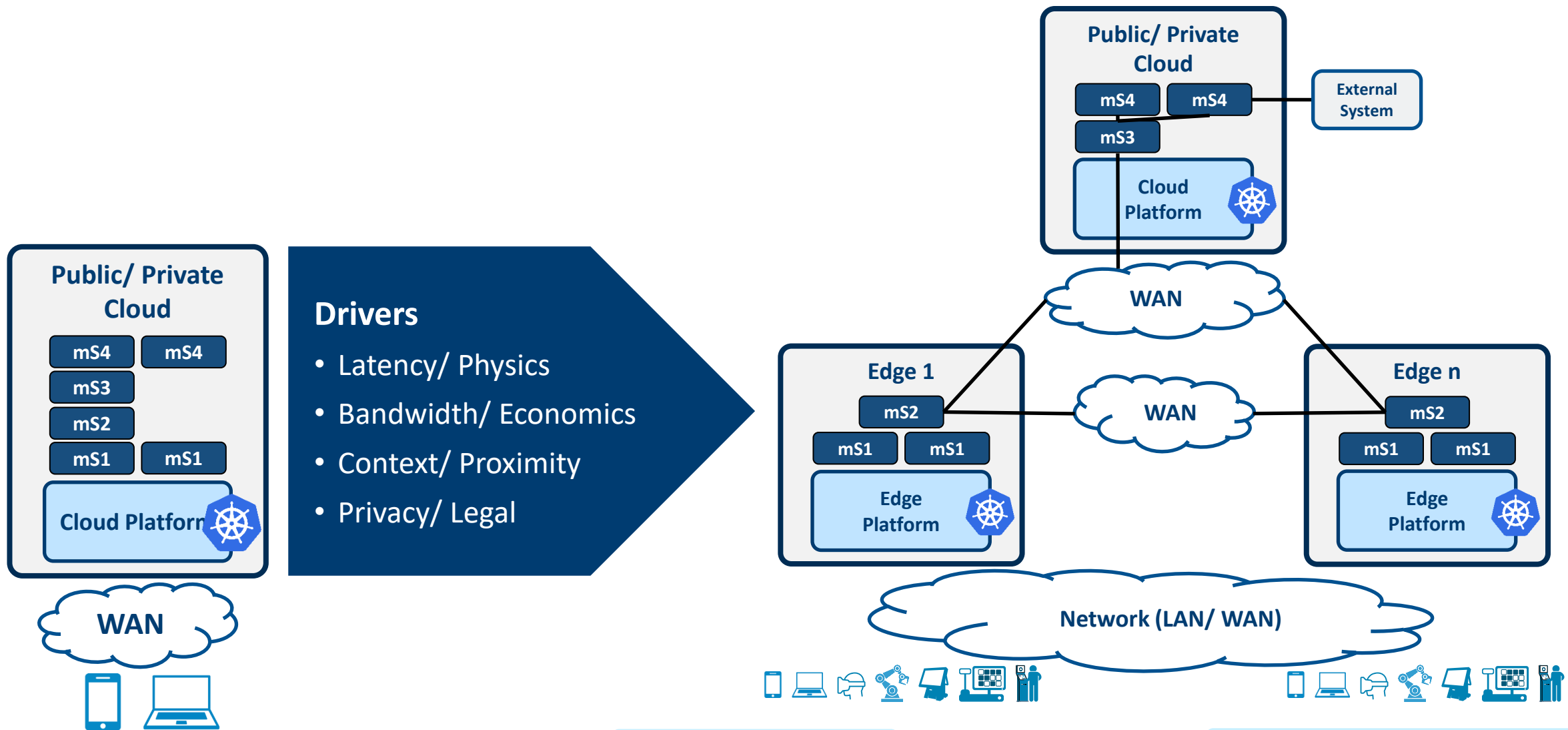# EMCO: Project Overview and Architecture

EMCO team

Agenda

- Drivers for Edge Computing
- How EMCO is addressing challenges
- Architecture overview
- Features at high level
- OpenAPIs and brief overview
- Use cases
- Q&A's

Trend : Geo Distributed Computing trend with Edge-computing

Public/ Private Cloud

mS4   mS4   External System

mS3

Cloud Platform

Public/ Private Cloud

mS4   mS4

mS3

mS2

mS1   mS1

Cloud Platform

Drivers

- Latency/ Physics
- Bandwidth/ Economics
- Context/ Proximity
- Privacy/ Legal

WAN

WAN

Edge 1

mS2

mS1   mS1

Edge Platform

Edge n
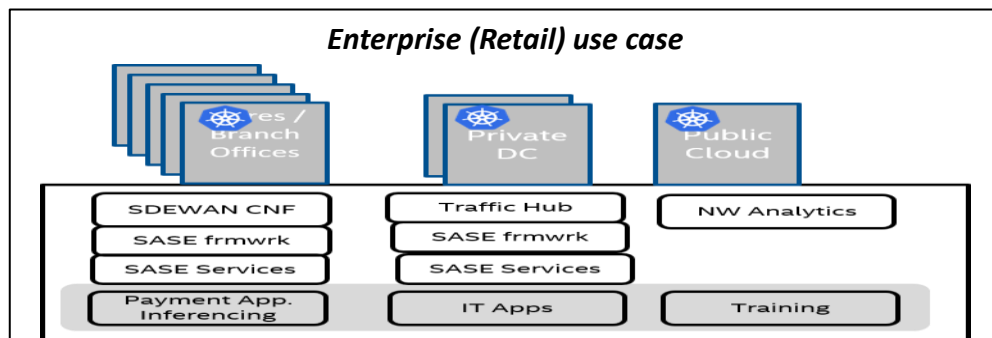
mS2

mS1   mS1

Edge Platform
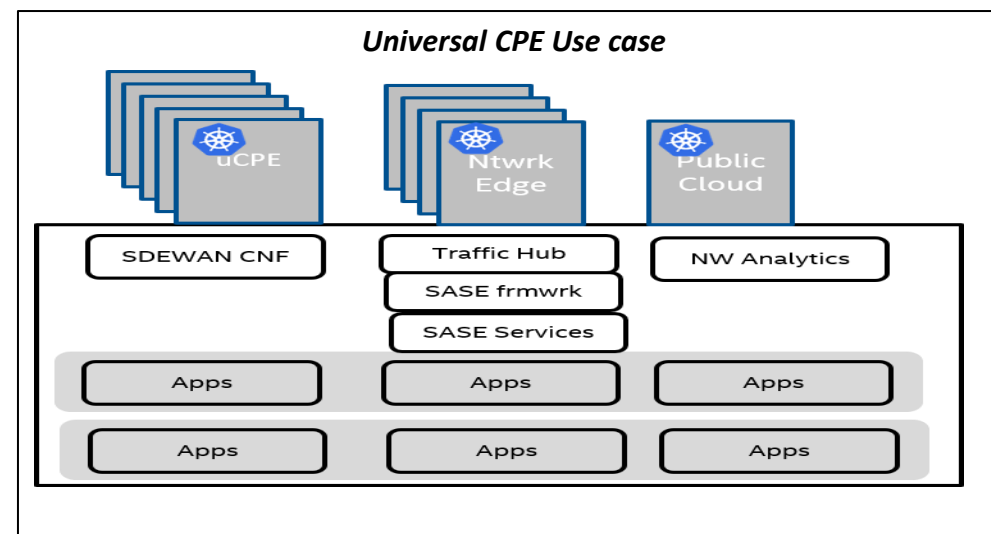
Network (LAN/ WAN)

On Demand   Geo-Distributed   App Centric infra Config

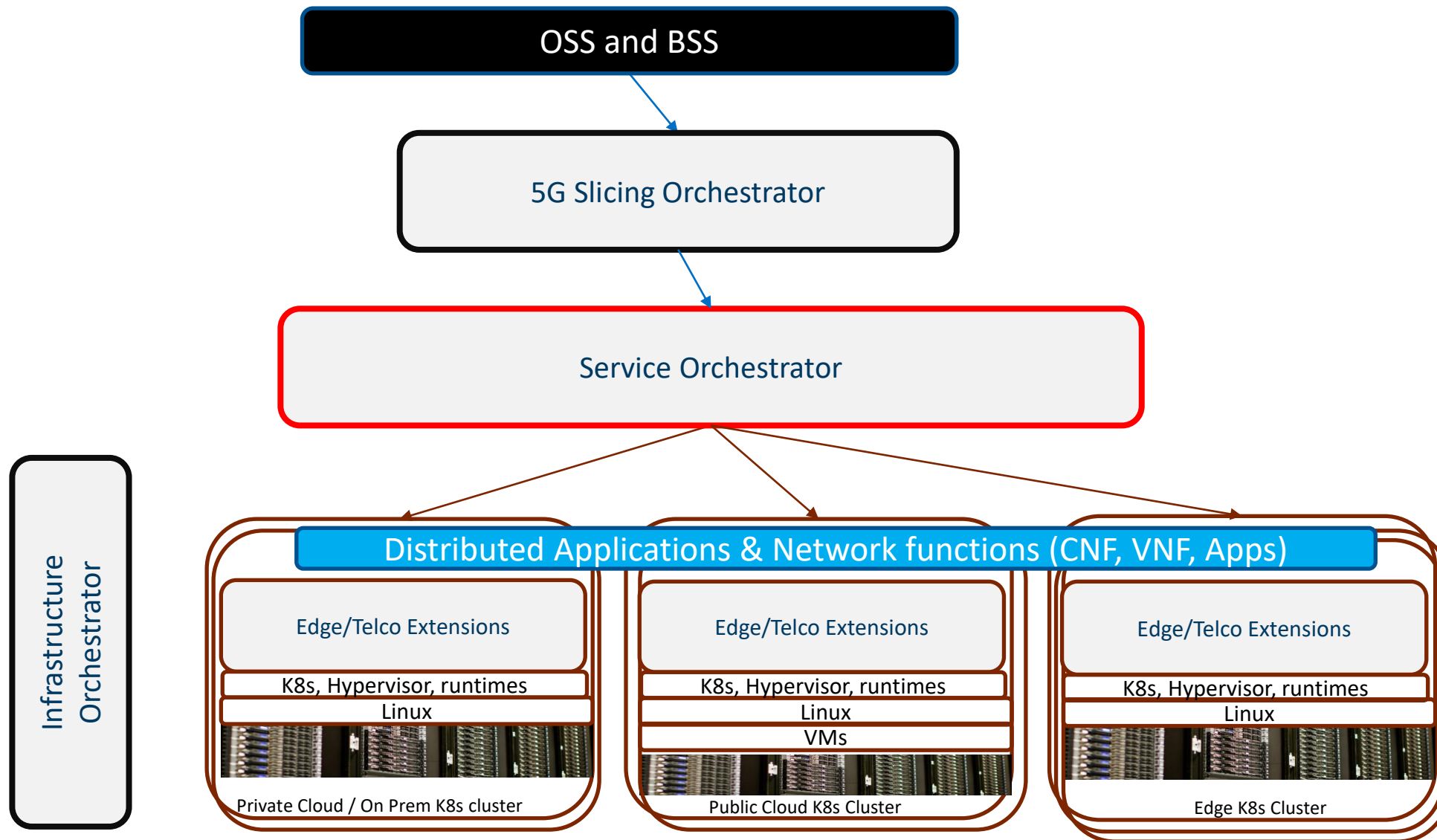# Geo-Distributed Computing - few use cases

5G Use case

Tens of Thousands	Low thousands	Hundreds	Tens	few
@Cell	CO DC	Local DC	RDC	Public Cloud

DU	CU-CP	AMF, SMF	5GC Control	Analytics/Training
	CU-UP	UPF	UPF	
	Inferencing	Inferencing		

Tenant X
| Apps | Apps | Apps |

Tenant Y
| Apps | Apps | Apps |

Universal CPE Use case

| uCPE | Ntwrk Edge | Public Cloud |

SDEWAN CNF	Traffic Hub	NW Analytics
	SASE frmwrk	
	SASE Services	

| Apps | Apps | Apps |
| Apps | Apps | Apps |

Enterprise (Retail) use case

| Stores / Branch Offices | Private DC | Public Cloud |

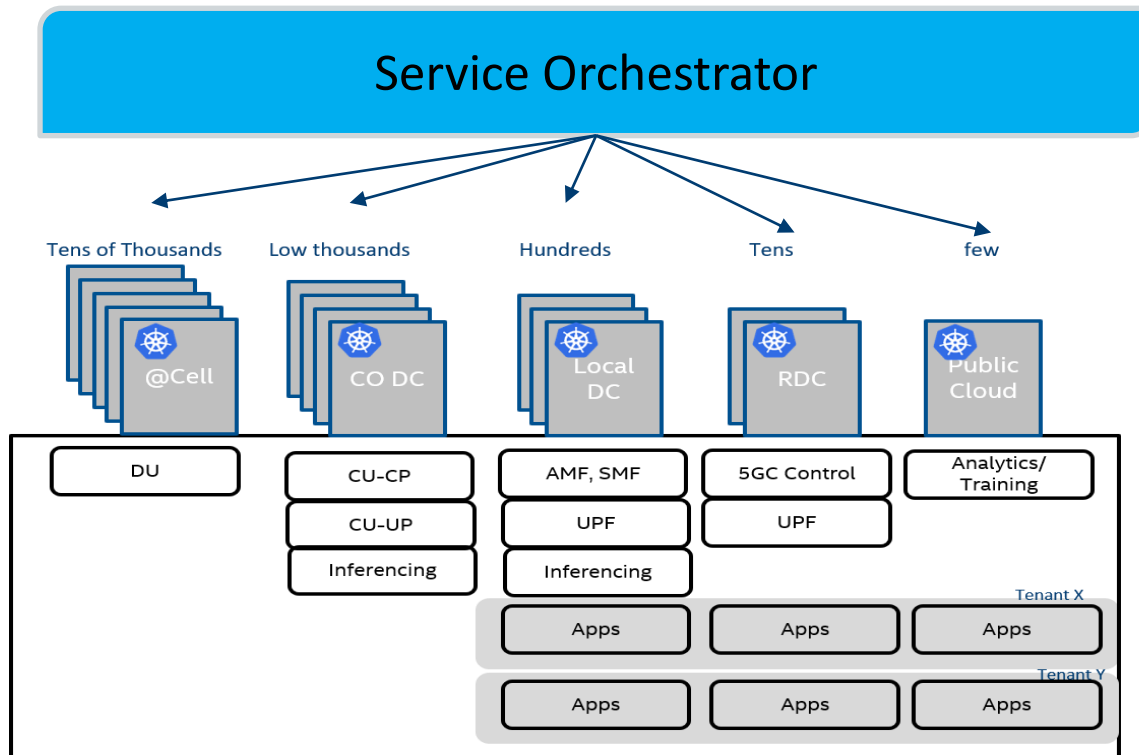| SDEWAN CNF | Traffic Hub | NW Analytics |
SASE frmwrk	SASE frmwrk	
SASE Services	SASE Services	
Payment App. Inferencing	IT Apps	Training

- *Large Number of sites*
- *Computing (Apps across sites) – MEC*
- *Multiple tenant applications along with operator CNFs.*
- *Workload types - VMs, VNFs, CNFs, CNAs and Functions (FaaS)*
- *Note: K8s is becoming choice of workload orchestrator in each cluster*

Multi Edge/Cloud computing scale is similar (or even higher) to Hyper-scalers' scale
Now Telcos, MSPs and Enterprises need @scale Orchestration and Automation solutions

EDGE MULTI-CLUSTER ORCHESTRATOR | EMCO

(intel)

E2E Edge Stack

OSS and BSS

5G Slicing Orchestrator

Service Orchestrator

Distributed Applications & Network functions (CNF, VNF, Apps)

Edge/Telco Extensions

K8s, Hypervisor, runtimes
Linux

Private Cloud / On Prem K8s cluster

Edge/Telco Extensions

K8s, Hypervisor, runtimes
Linux
VMs

Public Cloud K8s Cluster

Edge/Telco Extensions

K8s, Hypervisor, runtimes
Linux

Edge K8s Cluster

Infrastructure Orchestrator

Service Orchestrator – Big Picture

Service Orchestrator

Tens of Thousands — @Cell
Low thousands — CO DC
Hundreds — Local DC
Tens — RDC
few — Public Cloud

@Cell	CO DC	Local DC	RDC	Public Cloud
DU	CU-CP	AMF, SMF	5GC Control	Analytics/ Training
	CU-UP	UPF	UPF	
	Inferencing	Inferencing		

Tenant X

	Apps	Apps	Apps

Tenant Y

	Apps	Apps	Apps

- *One Click deployment of complex applications & network services across multiple K8s clusters*
- *Comprehensive Status monitoring of deployed complex applications*
- *One Service Orchestrator for both CNF/CNA, VNF/VMs*
- *Self Service Portal for multiple tenants*
- *Comprehensive Analytics platform for Day2 operations*
- *App Centric infrastructure configuration (Service Mesh, SDWAN, L2/L3 switches)*

intel

Needs/Requirements – Preparation

Service Orchestrator
- Cluster Provisioning
- Tenant Provisioning
- Logical Cluster Provisioning

Tens of Thousands	Low thousands	Hundreds	Tens	few
@Cell	CO DC	Logical cluster DC / Logical cluster	RDC	Public Cloud

DU	CU-CP	AMF, SMF	5GC Control	Analytics/ Training
	CU-UP	UPF	UPF	
	Inferencing	Inferencing		

Tenant X

| Apps | Apps | Apps |

Tenant Y

| Apps | Apps | Apps |
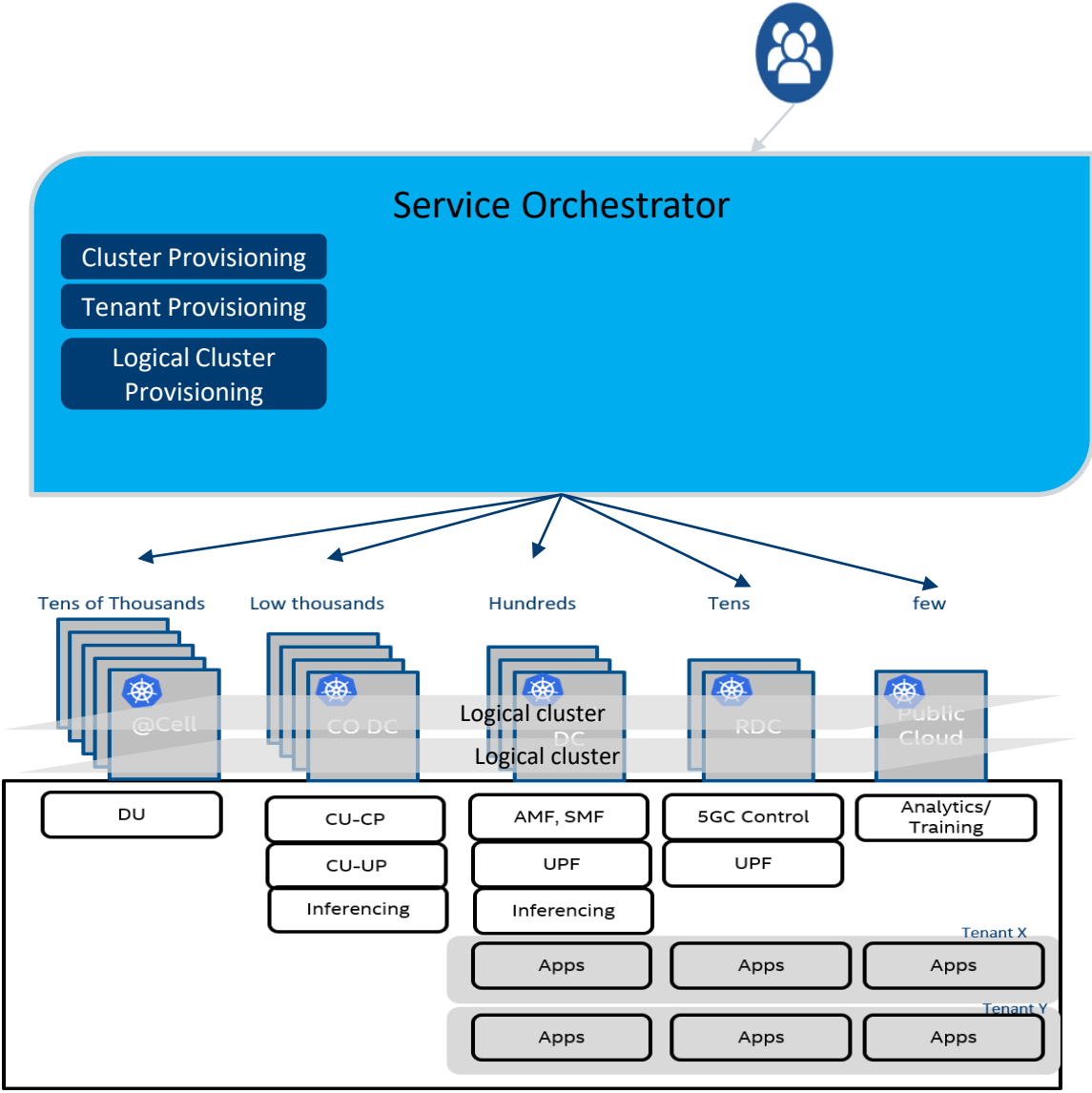
Registration of Clusters

*Cluster labels
(Example: Cell tower Edge, CO Edge etc..)
Needed for identifying multiple clusters*

*Cluster specific configuration
(Few: ISTIO CA provisioning;
Virtual/Provider network preparation)*

*Tenant registration
Ability to use tenant specific OAUTH2
servers for authenticating tenant admins*

Tenant level isolation via RBAC rules

*Logical Cluster provisioning across
multiple selected clusters*

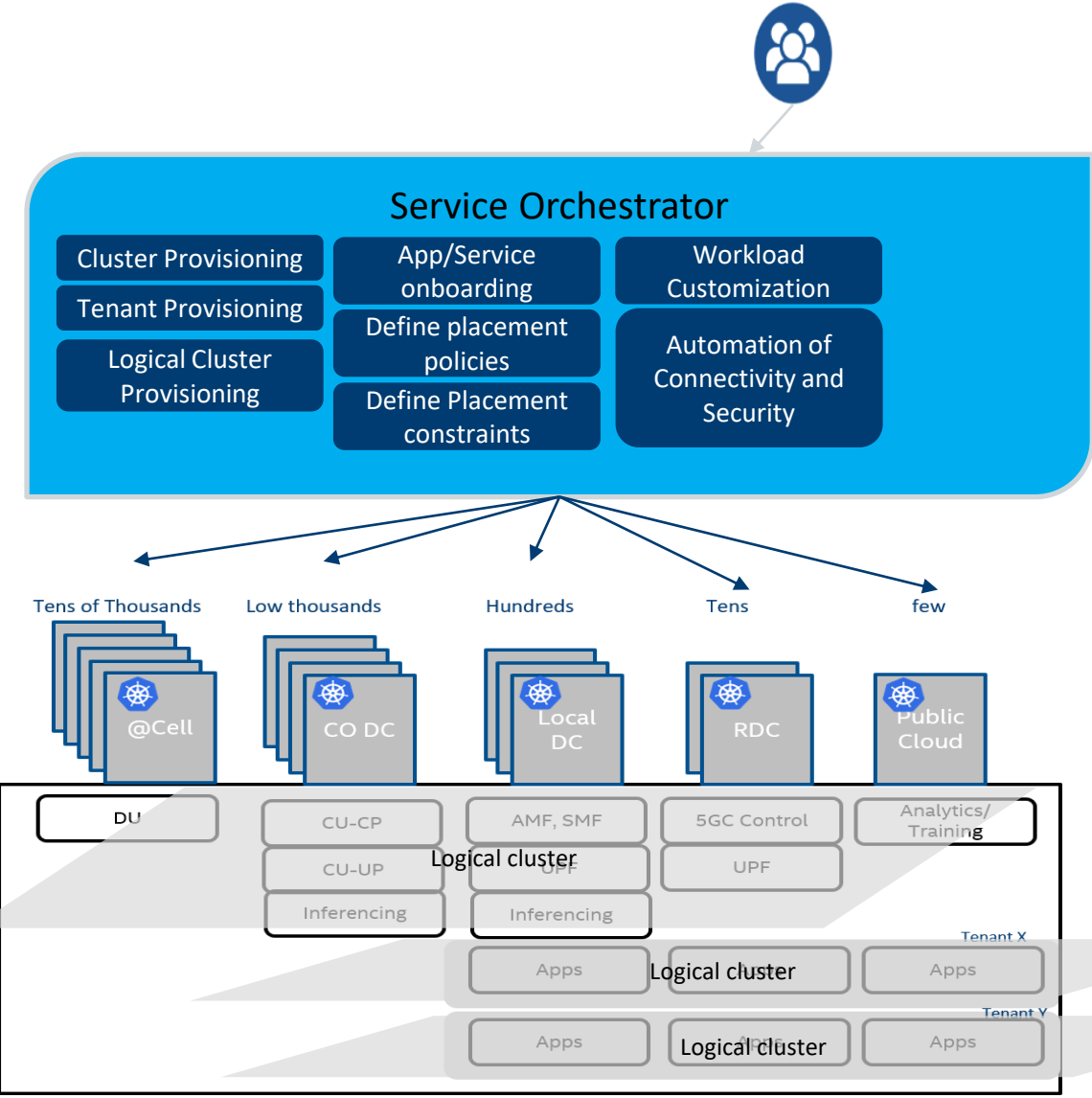*Logical Cluster user and permission
provisioning*

Needs/Requirements – Application deployment design

Service Orchestrator

- Cluster Provisioning
- Tenant Provisioning
- Logical Cluster Provisioning
- App/Service onboarding
- Define placement policies
- Define Placement constraints

Tens of Thousands — @Cell

Low thousands — CO DC

Hundreds — Local DC

Tens — RDC

few — Public Cloud

DU	CU-CP	AMF, SMF	5GC Control	Analytics/ Training
	CU-UP	UPF	UPF	
	Inferencing	Inferencing		

Logical cluster

Tenant X

| | | Apps | | Apps |

Logical cluster

Tenant Y

| | | Apps | Apps | Apps |

Logical cluster

App Onboarding (Complex Apps & Network Services)

Multiple deployment profiles to ensure same APP can be instantiated multiple times

Placement policies to replicate and distribute workloads across clusters

Placement constraints : Affinity and Anti-Affinity; Platform capabilities; Latency; Cost

(intel)

Requirements – Workload Customization & Connectivity management

Service Orchestrator

- Cluster Provisioning
- Tenant Provisioning
- Logical Cluster Provisioning
- App/Service onboarding
- Define placement policies
- Define Placement constraints
- Workload Customization
- Automation of Connectivity and Security

Tens of Thousands — @Cell

Low thousands — CO DC

Hundreds — Local DC

Tens — RDC

few — Public Cloud

DU	CU-CP	AMF, SMF	5GC Control	Analytics/ Training
	CU-UP	UPF	UPF	
	Inferencing	Inferencing		

Logical cluster

Logical cluster

Tenant X

| | | Apps | | Apps |
| | | Logical cluster | | |

Tenant Y

| | | Apps | Apps | Apps |
| | | Logical cluster | | |

No changes to helm charts/K8s description of applications

Each deployment may have its own customization

Connectivity intent provisioning
- *Enabling inter-micro service communication within or across clusters*
  - *Enabling communication to external entitles*
    - *With/Without Mutual TLS*
    - *Multi Cluster DNS management*

Dynamic provisioning with LCM of Applications

Extensible framework to add new capability controllers

(intel)

Requirements – Operations

Service Orchestrator

- Cluster Provisioning
- Tenant Provisioning
- Logical Cluster Provisioning
- App/Service onboarding
- Define placement policies
- Define Placement constraints
- Workload Customization
- Automation of connectivity and security
- Continuous App monitoring
- Analytics & Closed loop automation
- Day2 Config Controllers

Tens of Thousands | Low thousands | Hundreds | Tens | few

@Cell | CO DC | Local DC | RDC | Public Cloud

DU | CU-CP | AMF, SMF | 5GC Control | Analytics/Training
| CU-UP | UPF | UPF |
Logical cluster
| Inferencing | Inferencing |

Apps | Apps
Logical cluster
Tenant X

Apps | Apps
Logical cluster
Tenant Y

Continuous monitoring of complex Application (Across clusters, apps and micro-services)

Comprehensive report on the application status

Analytics framework
- Metric collection across clusters & apps
- Long term central store (Time Series)
- Training framework
- Closed loop policy management

Day 2 Configuration
- Configuration of apps/network-functions that are already deployed.
- Various types of configurations (CR based, RESTful based or Netconf/yang based)
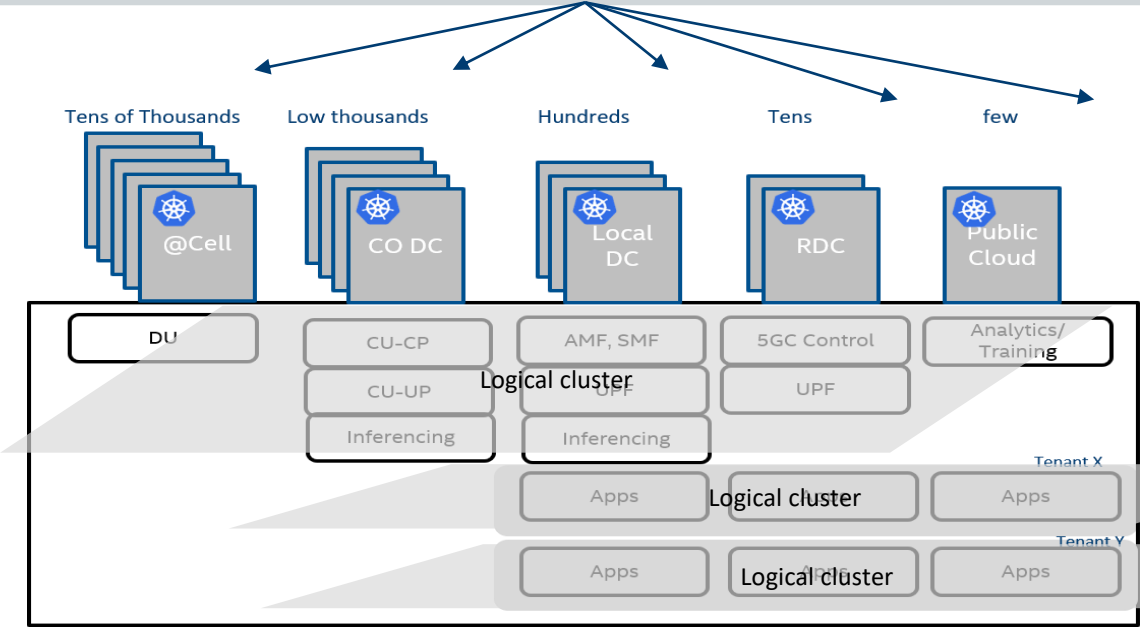
EMCO – Edge Multi Cluster Orchestrator

EMCO is an implementation of Service Orchestrator
Addressing majority of requirements; Extensible architecture allows new
automation requirements

EMCO

CLI/GUI

| Cluster Registration Controller | Distributed Application scheduler | Hardware Platform Aware Controller | Distributed Cloud Manager |
| | | Traffic Connectivity & Security Controller | Day2Cfg Generic |

Resource Synchronizer & Status Monitoring

Platforms

Enterprise Edges   Edge Clouds   Network Edges   Telco CO Edges   Pub/Pvt Clouds
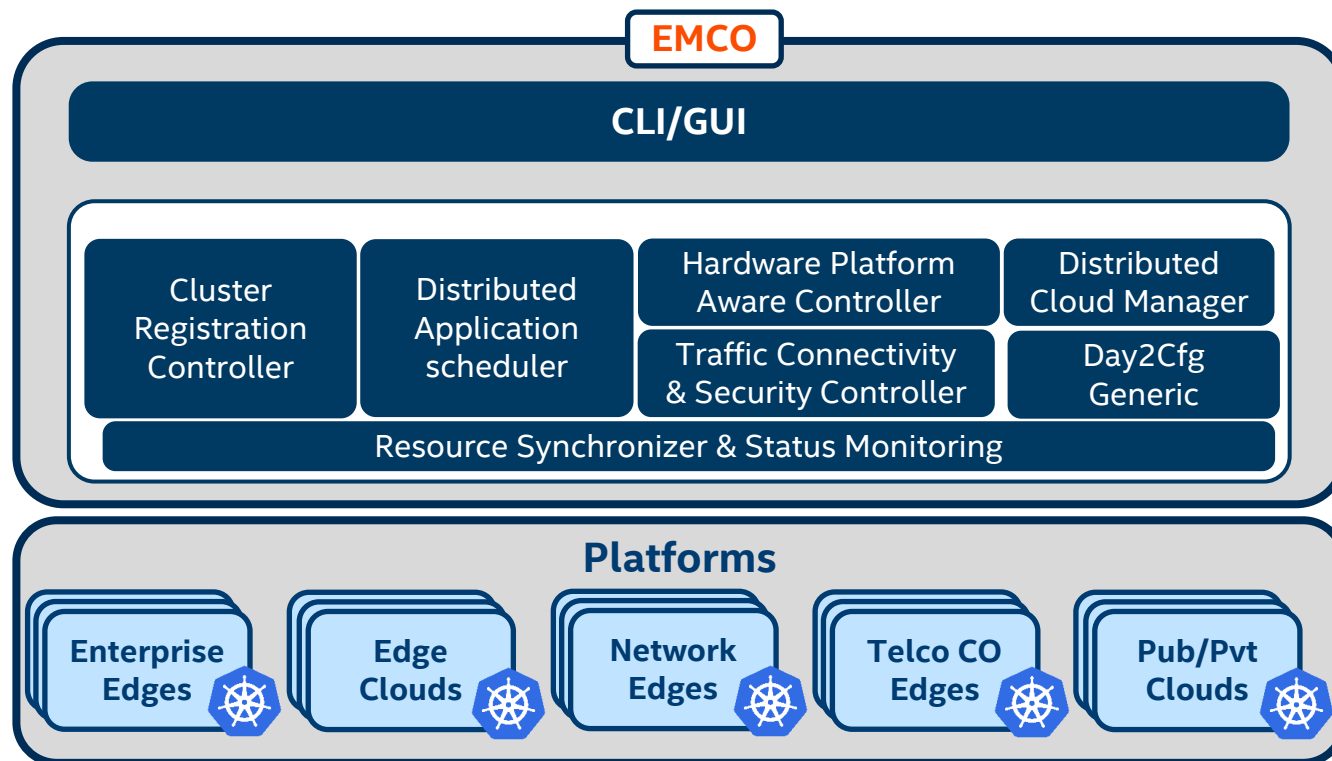
- **Cluster Registration Controller** registers clusters by cluster owners
- **Distributed Application Scheduler** provides simplified, and extensible placement; tenant mgmt; LCM implementation
- **Hardware Platform Aware Controller** enables scheduling with auto-discovery of platform features/ capabilities; Others: Cost, Power Savings, Latency aware… (WIP)
- **Distributed Cloud Manager** presents a single logical cloud from multiple edges
- **Traffic Connectivity controller** auto-configure service mesh (ISTIO) and security policy (NAT, firewall), DNS and SLB entities of edges - WIP
- **Day2 generic configuration** configures Day2 configuration of any app/network function via templates & configs - WIP
- **Resource Synchronizer & Monitoring** synchronizes resources across multiple edge/cloud platforms and then monitors the status of deployed resources

EMCO Architecture
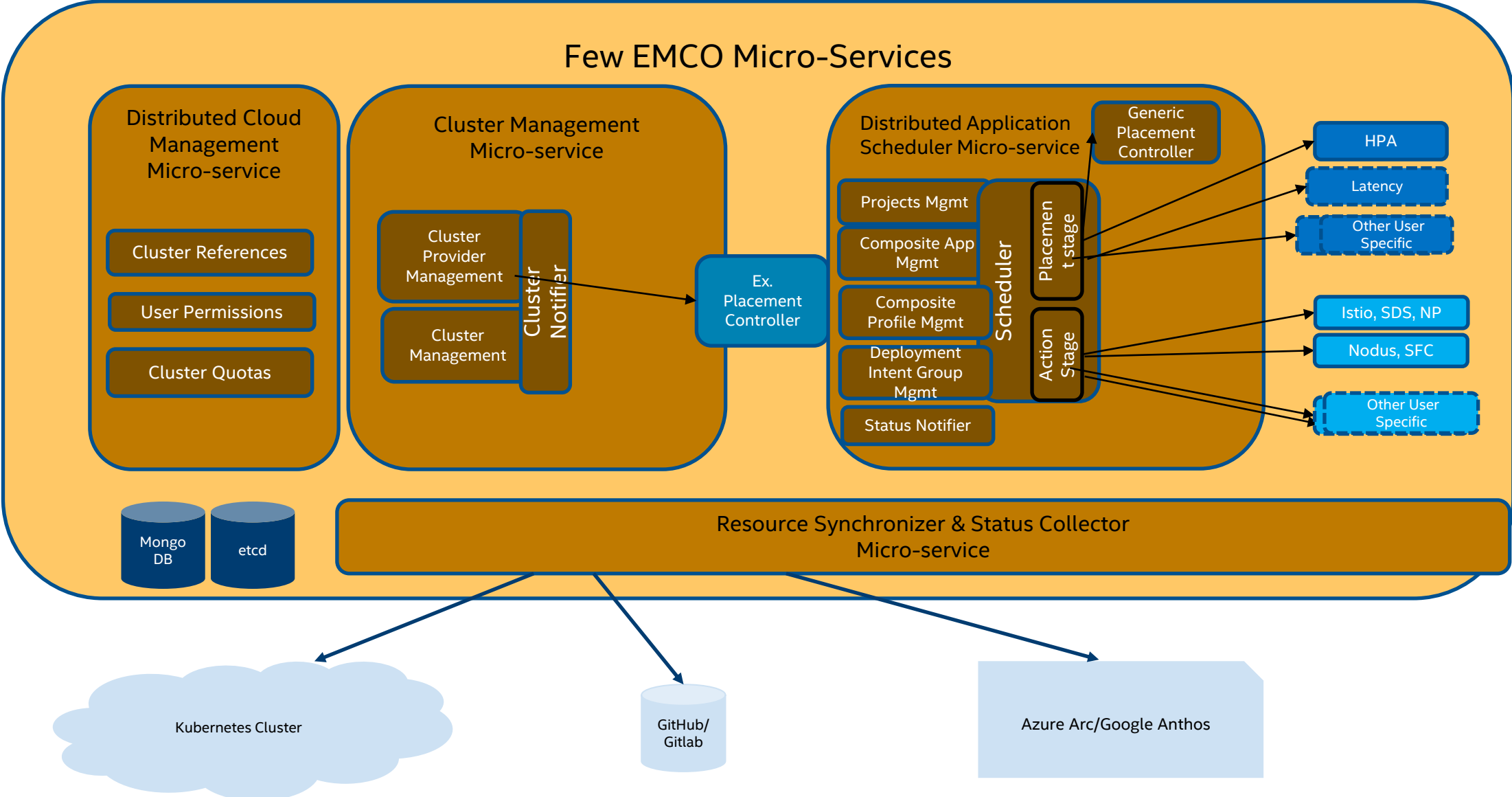
EMCO Features

- Extensible Architecture

  - Placement controllers

  - Action controllers

- Intent based architecture

- On-demand instantiation of applications on K8s clusters

- Intelligent selection of clusters to place the workloads

- Tenant Isolation using logical clouds

- Customization of resources in the applications based on clusters

EMCO Features Contd.

- Monitoring of resources deployed by EMCO

  - Notification framework for per app, per cluster, per resource

- Automation of service mesh and other connectivity & security infrastructure

- Dependency and order of priority of application deployments between clusters

- Update and Rollbacks

  - Update applications, resources for existing applications and/or add/delete clusters for applications

- On-demand scale-out of the applications

EMCO Features Contd.

- Nodus Support (https://github.com/akraino-edge-stack/icn-nodus)

  - Network Configuration Management (NCM) Controller

  - OvnAction Controller

  - SFC Controllers

- Referential Integrity

- Service Discovery Controller

EMCO Features (Under development)

- Rsync Plugin Architecture (available in 21.12 release)
  - K8s Cluster
  - WIP/Planned Plugins
    - Fluxv2
    - Azure Arc
    - Google Anthos
  - Others….

EMCO OpenAPI's

- API Concepts
  - Projects
  - Composite Apps, Composite Profiles
  - Deployment Intent Group
  - Generic Placement Intent
  - Controllers
  - Clusters
  - Logical Clouds
  - Traffic controller, Nodus, HPA, ….
- Link to the API

  https://gitlab.com/project-emco/core/emco-base/-/raw/main/docs/swagger-specs-for-APIs/emco_apis.yaml

Test Usecases

- vFW

- Prometheus

- Free5gc

vFW Use Case – Standalone
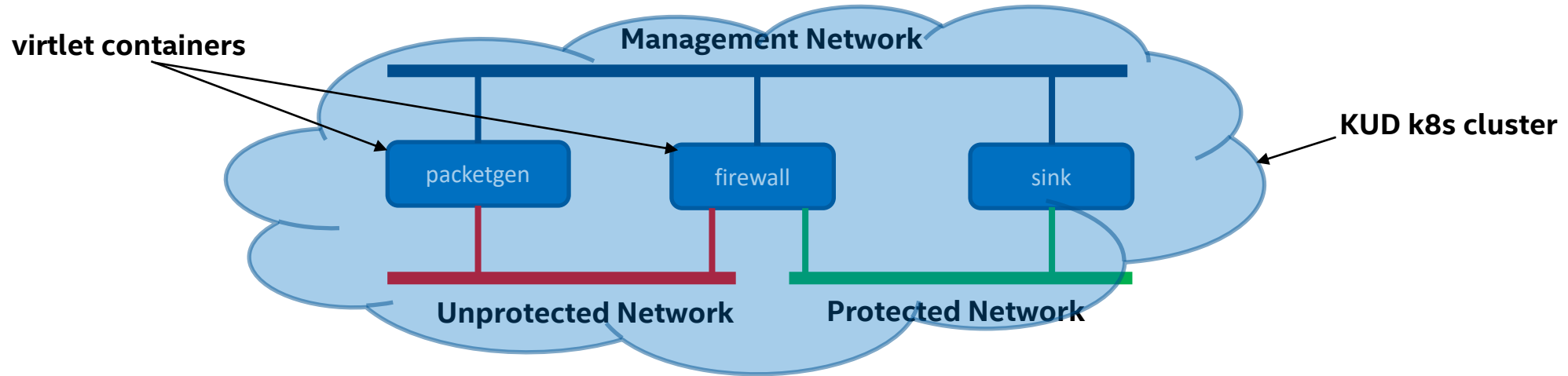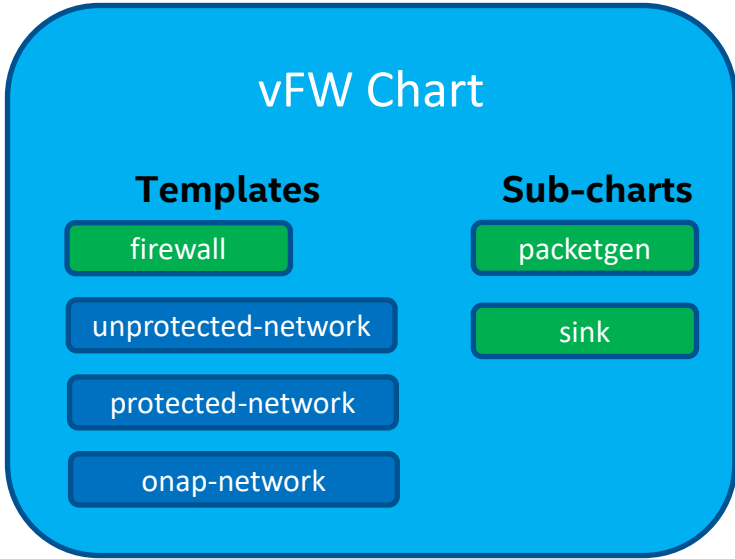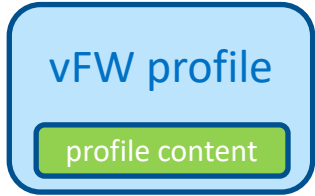
vFW – set up clusters and controllers
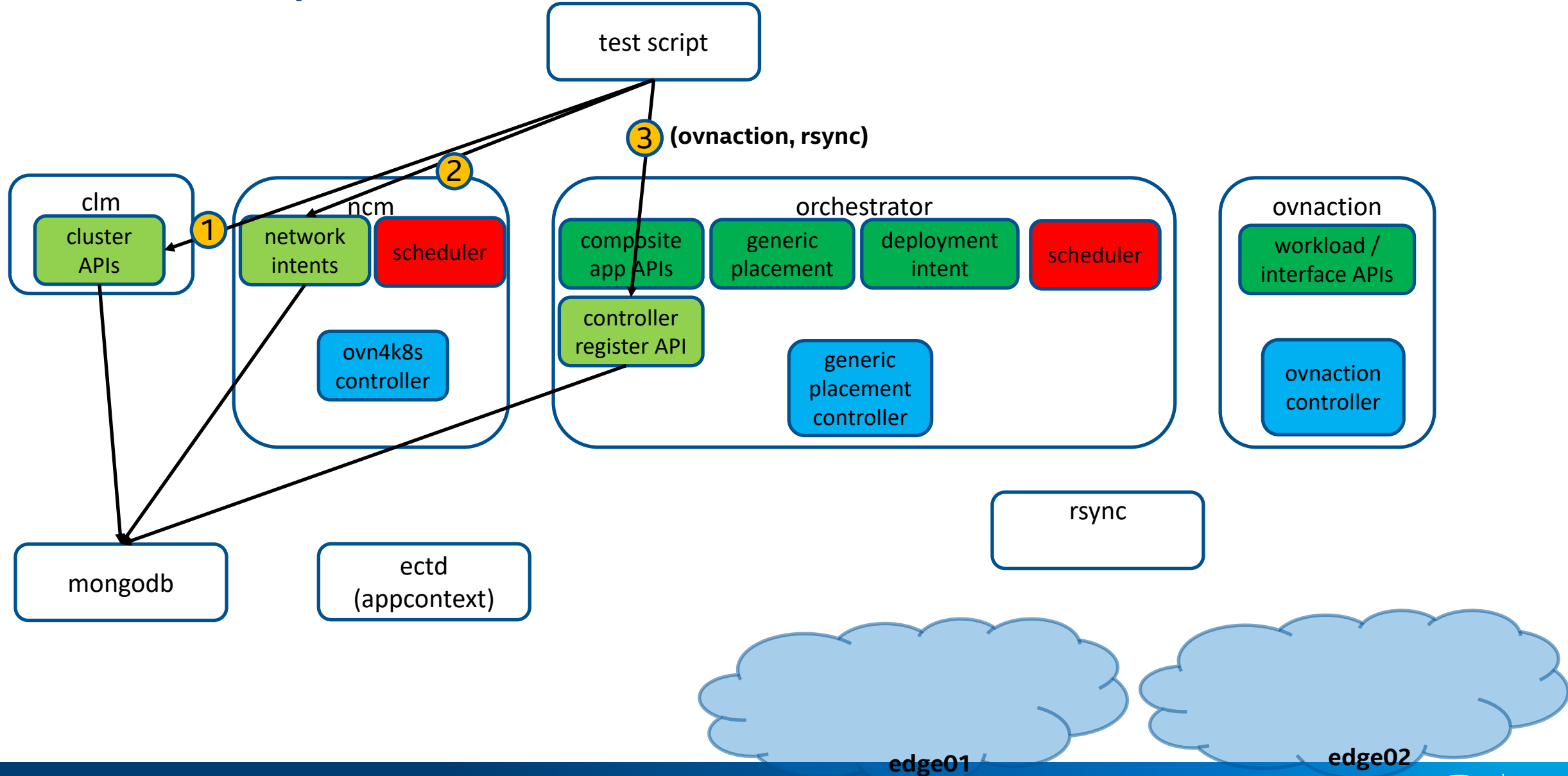
vFW – set up the composite app and intents
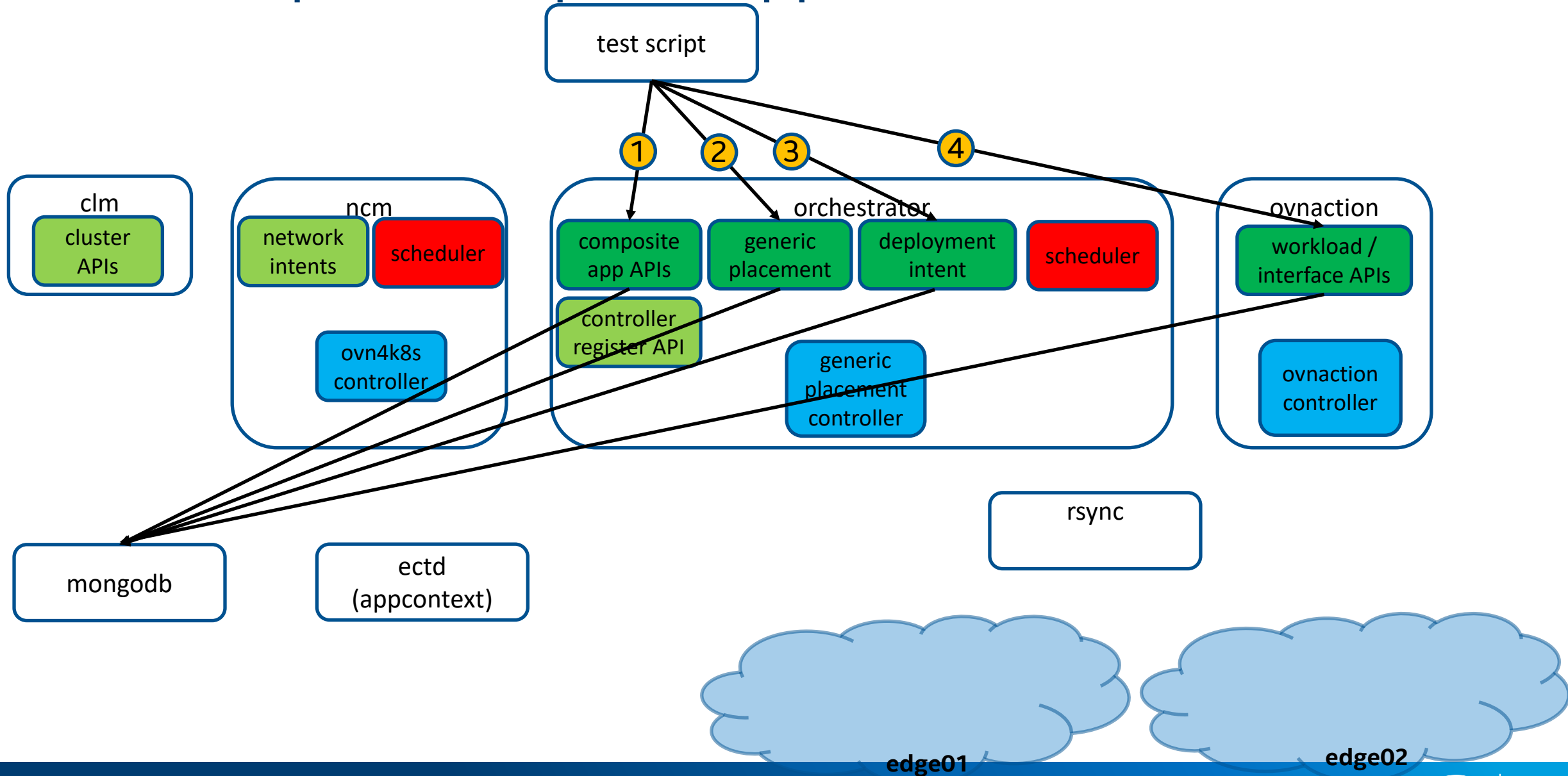
vFW – apply the network intents
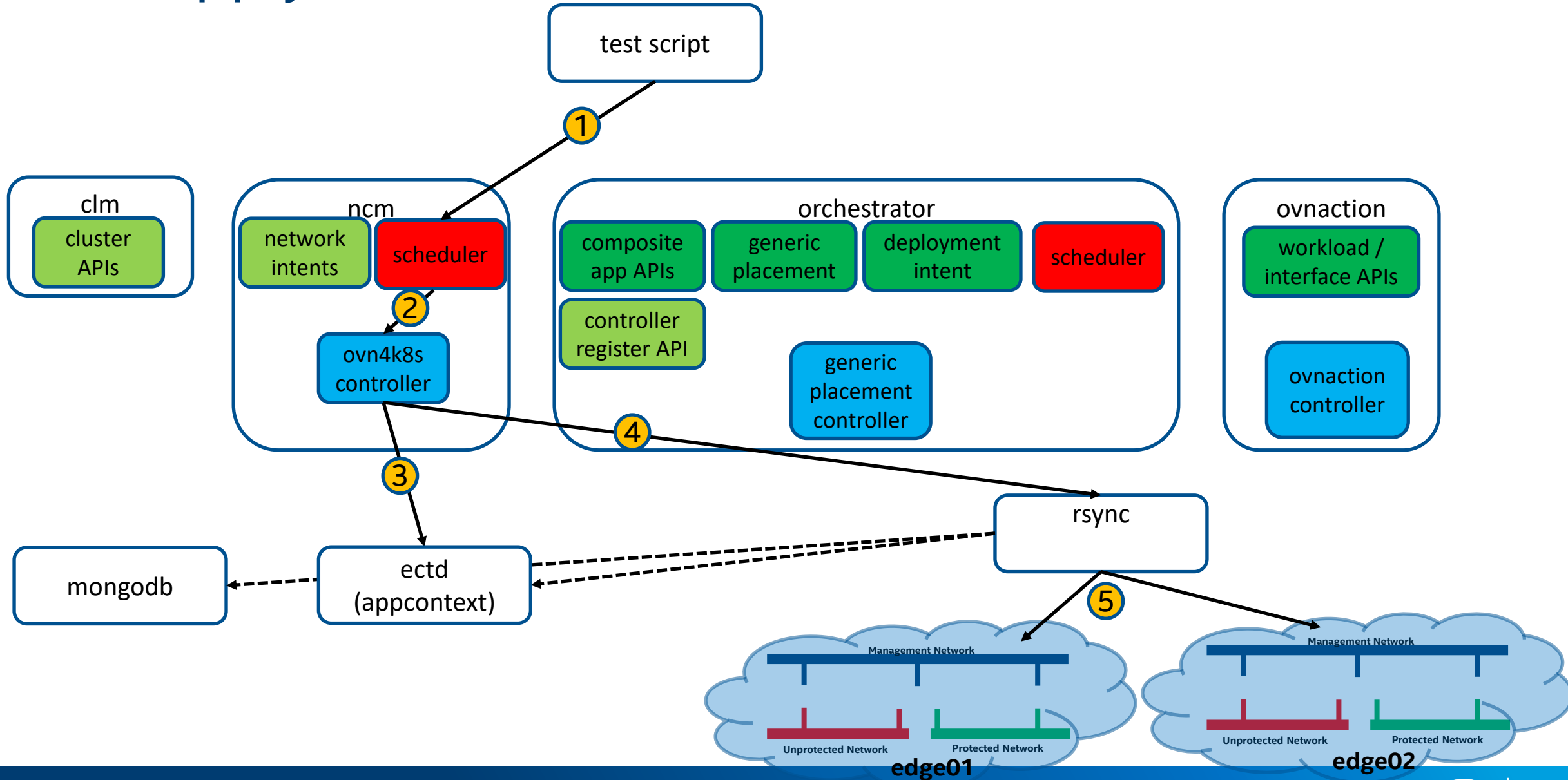
vFW – instantiate a specific deployment intent
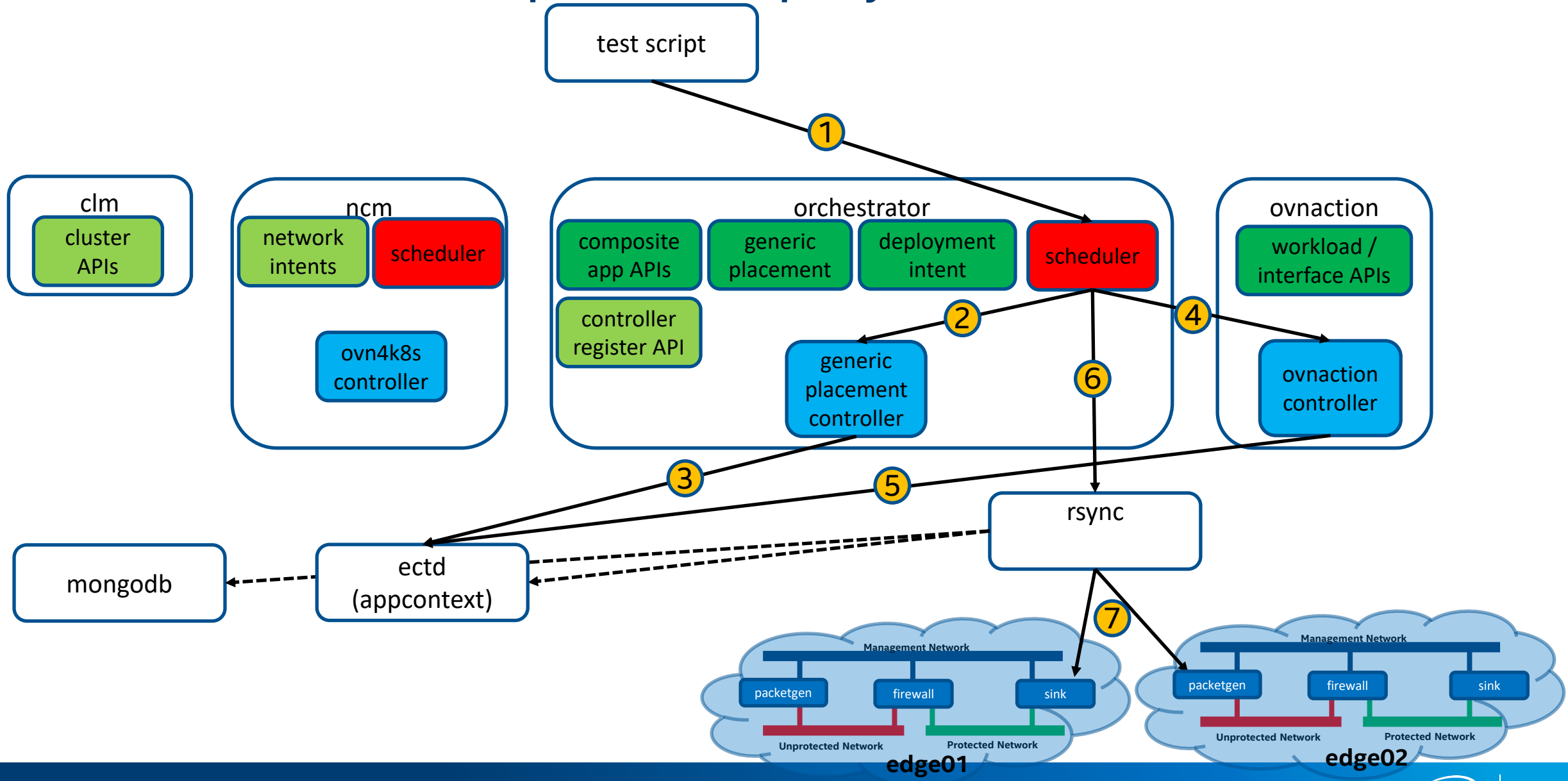
v2 API resources

Controller registrations

ovnaction

rsync

Cluster Provider

cluster edge01

cluster edge02

Provider Network Intents

onap-network

unprotected-network

Virtual Network Intents

protected-network

vFW Composite Application

packetgen chart
Templates
- packetgen deployment
- packetgen service

firewall chart
Templates
- firewall deployment

sink chart
Templates
- sink deployment
- sink configmap
- sink service

vFW Composite Profile

packetgen profile
- profile content

firewall profile
- profile content

sink profile
- profile content

Network Control Intents

packetgen workload intent
Interface Intents
- onap-net i/f intent
- unprotected i/f intent
- protected i/f intent

firewall workload intent
Interface Intents
- onap-net i/f intent
- unprotected i/f intent
- protected i/f intent

sink workload intent
Interface Intents
- onap-net i/f intent
- unprotected i/f intent
- protected i/f intent

Generic Placement Intent

packetgen placement intent

firewall placement intent

sink placement intent

Deployment Intent

placement: generic placement

action: ovnaction

24

(intel)

EMCO Journey

- V1 version of the EMCO API are called k8splugin under multicloud-k8s project in ONAP.

- V2 incubated as a subproject, ONAP4k8S, under ONAP since 2019.

- Garnered following of several companies in ONAP.

- Moved under the Intel OpenNESS umbrella/repo in late 2020.

- Renamed EMCO, source drops provided back to ONAP users. Several releases of EMCO were made under OpenNESS.

- ONAP community formally requested that EMCO return to open governance March 2021- **LF Leadership suggested LFN**.

- Intel approved move back to LF May 2021; formation commenced July '21.

- TSC established August 24, 2021 (11 Representatives from different companies).

- LFN TAC approved EMCO as a sandbox project under LFN umbrella on September 22nd.

- Active open source EMCO development moved to LFN under gitlab on October 1st.

EMCO under LFN

- **Project name:** EMCO
- **Project creation date:** July 20 , 2021 (Formation KickOff)
- **Project license:** Apache 2.0
- **Multiple company plans to contribute to code base**
  - Intel, Aarna, Cango, Verizon, Tech Mahindra
- **EMCO Gitlab project:**
  - **Includes emco-base and emco-gui**
  - **Emco-base contributed by Intel and emco-gui by Aarna Networks**
  - **Repos:** https://gitlab.com/project-emco/ui/emco-gui https://gitlab.com/project-emco/core/emco-base
  - **Release Schedule:**
    - **Releases Planned for Sept (seed code) and Dec 2021**
      More detail on Roadmap slide below

EMCO Integrations

Part of these commercial solutions
Part of AMCOP solution from Aarna: https://www.aarnanetworks.com/amcop
Commercial Support
Calsoft SI: https://www.calsoftinc.com/news/calsoft-announces-commercial-support-for-akraino-led-icn-integrated-cloud-native-blueprint/

Few Blueprints in LFE/Akraino use EMCO for Multi Cluster Orchestration
free5GC deployments using EMCO by Aarna networks

ONAP uses EMCOv1 to Onboard/design network services and deploy on K8s clusters

ONAP Slicing Orchestrator uses EMCOv1 for Day 2 LCM

Thank You!!
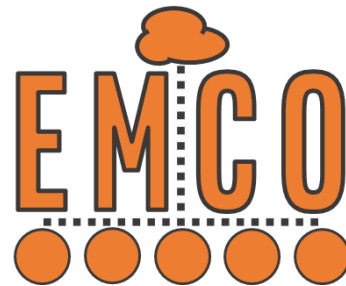
Backup

EMCO Vision

Be a comprehensive geo-distributed Cloud native application orchestrator

Be a Multi-Party and Multi-Cloud Orchestrator

Be an orchestrator for Network services and Enterprise applications

Be an orchestrator for convergence of Network services and Enterprise applications

Be an orchestrator for Distributed Clouds with Edge-computing

What is not in the scope of EMCO?

EMCO does not expose ETSI and Tmforum APIs.

EMCO does not deploy workloads in non-K8s environments

EMCO CNF/App configuration is limited to K8s CR based apps/CNFs. It does not support NetConf, CLI and other mechanisms as of now.

EMCO does not include Analytics stack

Few distributions of third-party service orchestrators leveraging EMCO combine other projects such as ONAP CDS, ONAP DCAE to address brownfield deployments.