5G AutoMEC – Boosting edge-to-edge service continuity for CAM in a sliced network

Girma M. Yilma, Umberto Fattore, Marco Liebsch – NEC Laboratories Europe GmbH

Nina Slamnik-Kriještorac, Johann M. Marquez-Barja – University of Antwerp - imec, IDLab

Andreas Heider-Aviet – Deutsche Telekom

IEEE 5G for CAM – Connected and Automated Mobility

IEEE 5G Virtual Summit (Brussels)

11-12 May 2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825012

Outline

- Evolution towards a 5G Ecosystem – Enablers and edge-to-edge aspects
- Network Slicing – The ultimate "Umbrella" enabler
- Orchestrated Edges – Management of distributed resources on-demand
- Edge slice resources management PoC
- Conclusion

Evolution towards a 5G Ecosystem for CAM

Enabling Technology & Players

- 3GPP 5G System
  - Clean control-/data plane split, slicing support
  - Adoption of cloud-native and service-based communication principles
  - Network exposure function & APIs
  - Data analytics
- Network Function Virtualization (NFV)
  - Management & Orchestration of network/service functions
  - Automation
  - Federation enablers
- Multi-Access Edge Computing
  - Common platform for distributed service deployment
  - Provisioning of value added services (VAS)
  - Service- and platform interfaces
  - NFV enabled

Evolution towards a 5G Ecosystem for CAM

From end-to-end towards edge-to-edge

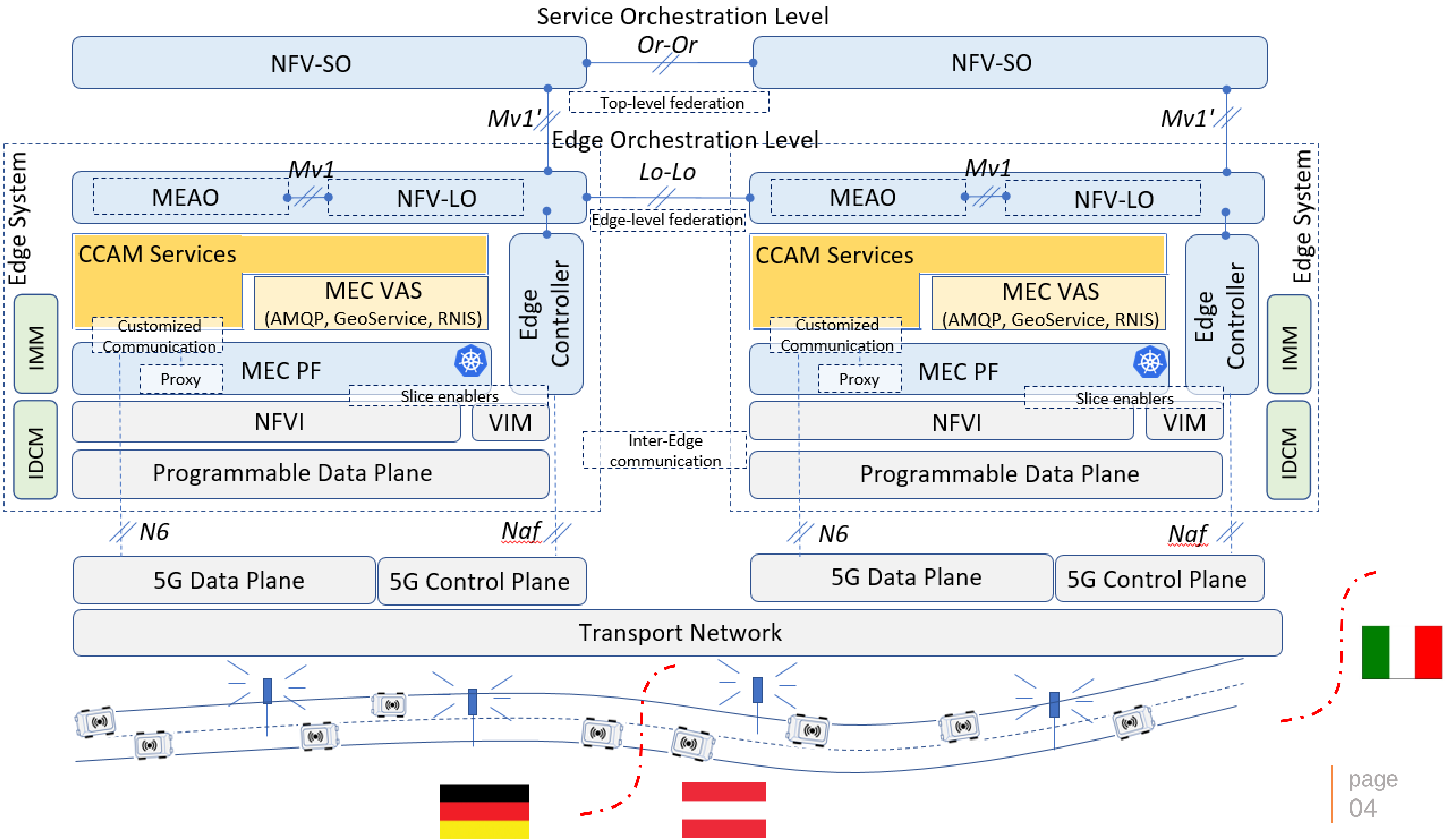
Management & Orchestration Level

MEC System Level

MEC Host Level

Data Plane Overlay

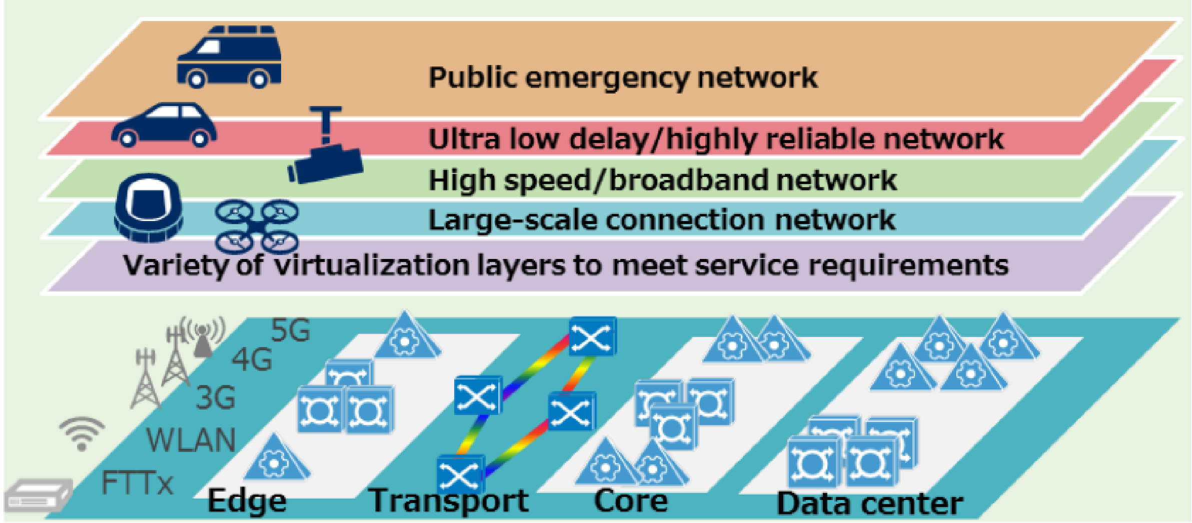
5G System Level



Network Slicing

The ultimate “Umbrella” enabler

- Isolation of network- and service deployments
- Network customization, multi-tenancy
- Service quality differentiation


Public emergency network
Ultra low delay/highly reliable network
High speed/broadband network
Large-scale connection network
Variety of virtualization layers to meet service requirements
5G
4G
3G
WLAN
FTTx
Edge
Transport
Core
Data center

- From customer intent, high-level descriptors, SLAs, slice templates ..

to...

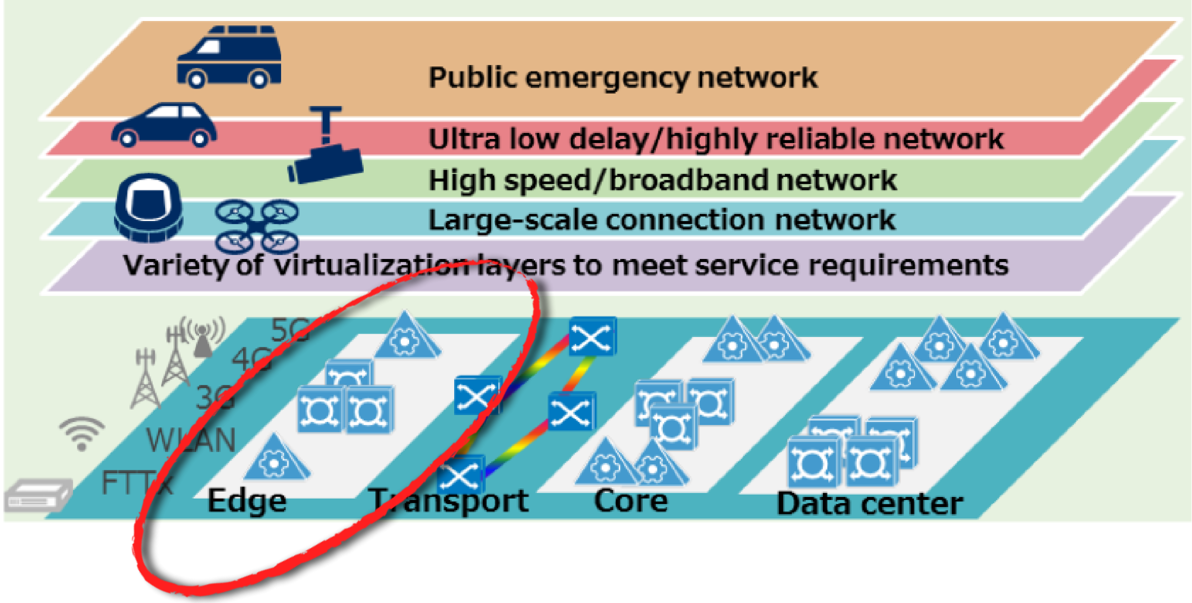
- .. low-level configurations, data models, policy enforcement, network programming, resources management, ..

- Slice may span over multiple domains and end-to-end over multiple subnetwork slices (central office, transport network, distributed network edges, radio access networks)
- Need for service/network isolation and resources management (reservation, multiplexing, overbooking)
- Decentralized deployment: Need for on-demand resources allocation at network edges

Network Slicing

The ultimate “Umbrella” enabler

- Isolation of network- and service deployments
- Network customization, multi-tenancy
- Service quality differentiation


Public emergency network
Ultra low delay/highly reliable network
High speed/broadband network
Large-scale connection network
Variety of virtualization layers to meet service requirements
5G
4G
3G
WLAN
FTTX
Edge
Transport
Core
Data center

- From customer intent, high-level descriptors, SLAs, slice templates ..

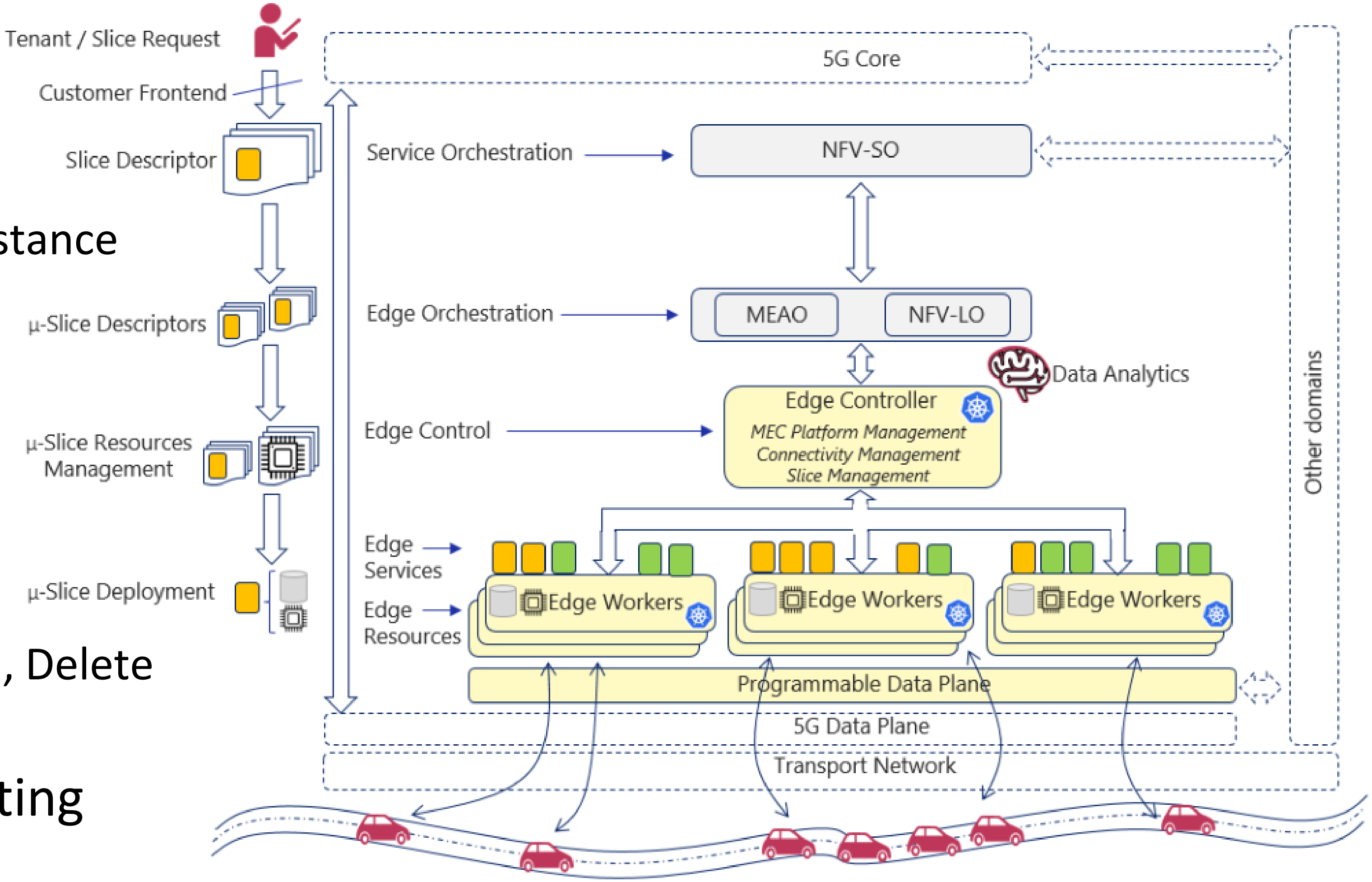
to...

- .. low-level configurations, data models, policy enforcement, network programming, resources management, ..

- Slice may span over multiple domains and end-to-end over multiple subnetwork slices (central office, transport network, distributed network edges, radio access networks)
- Need for service/network isolation and resources management (reservation, multiplexing, overbooking)
- Decentralized deployment: Need for on-demand resources allocation at network edges

Orchestrated Edges –
A slice as a system of distributed service instances

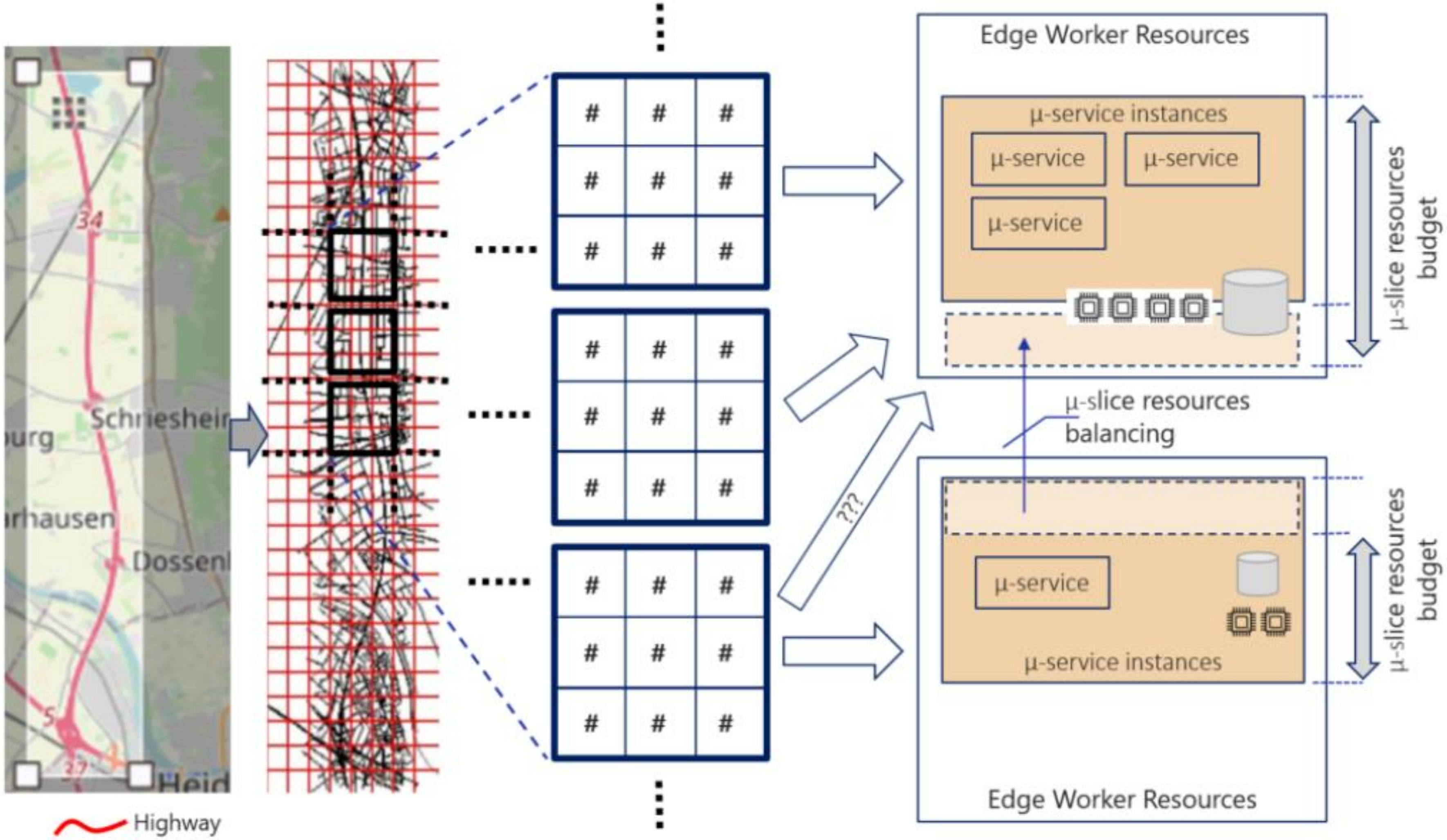
- Slice Admission Control
- Slice Management API
  - Create, Updates, Delete slice instance
- Mobile Edge Application Orchestration (MEAO)
  - Generates subnetwork slice policy update
- Edge Controller
  - Creates, Updates (Scale up/out), Delete App instances in a slice
- Slice usage monitor and reporting



Distributed Resources Allocation per Demand –

Leveraging demand predictions for µ-slice resources management

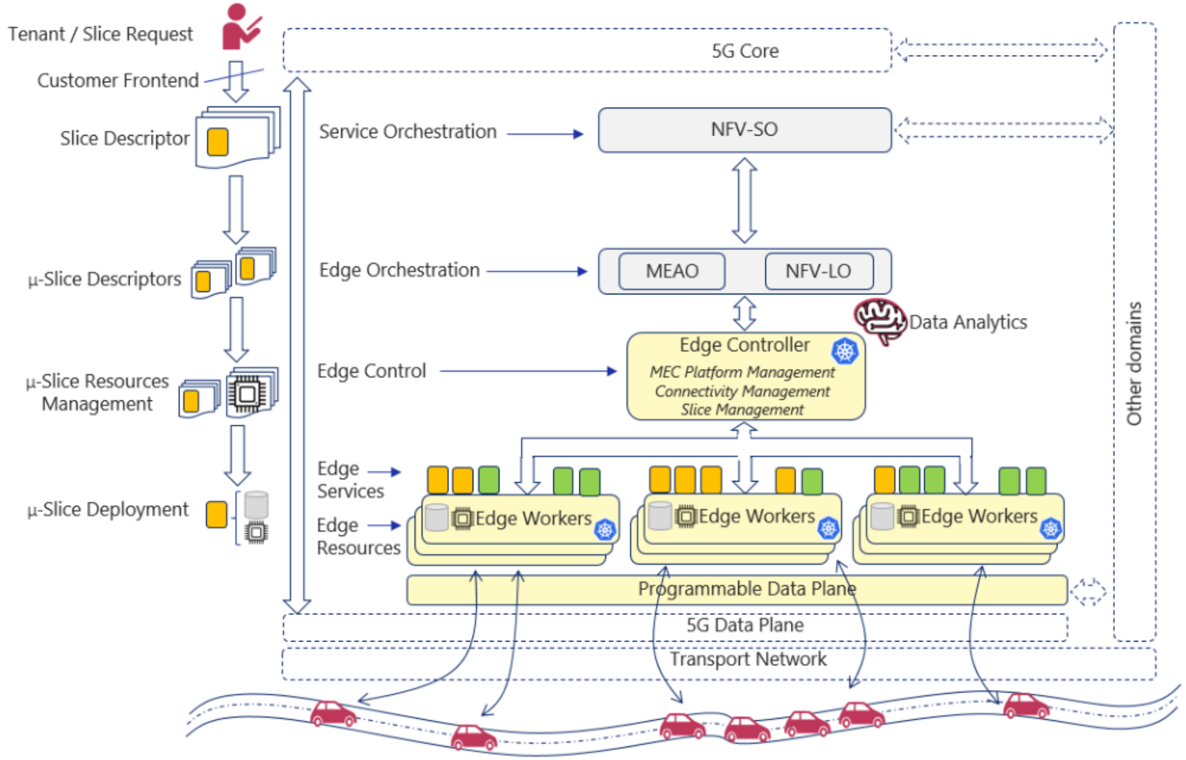
- Break edge subnetwork slice resources down to per-edge worker resource budget (µ-slice resources)
- Predict traffic per geo-cell/group of geo-cells
- Use prediction to configure µ-slice resource quota



Edge slice resource management PoC

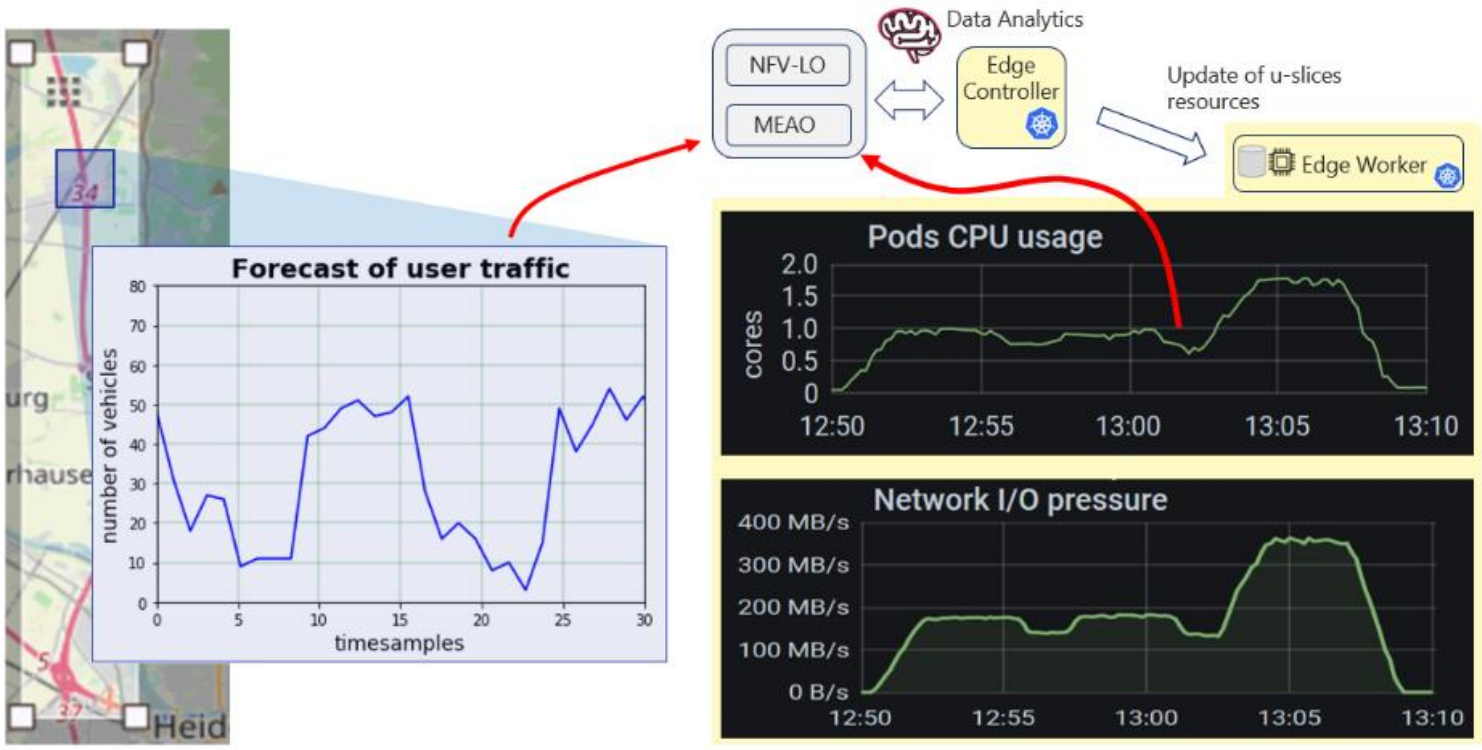
Cloud-native slice abstraction at the edge

- Edge application orchestration –
  Interplay: MEAO – NFV-LO – Edge Controller – K8s Edge Worker nodes
- “Slice” = Kubernetes namespace + Resource quota + Node affinity
- Kubernetes namespaces
  - provide scope for K8s objects
- Resource quota
  - allows configuration of resources for K8s namespaces, pods, ...
- Node affinity
  - allows control about where to place a container network function



Distributed Resources Allocation per Demand – Experimental proof

- Orchestrated container edges as experimental system
- Data about vehicular traffic patterns
- NF placement based on predicted mobility/density
- Predictions based on RNN/LSTM with 3 layers
- Scale-up/scale-out on demand and in advance



Conclusion

- Defined cloud native slice abstraction
- Developed OpenAPIs and interface to manage slice Life Cycle@edges
- Introduced the concept of geo/traffic-aware µ-slices
- Validated a proactive slice resource update POC
- Apply orchestrated edges to upcoming 5G slicing approach

Thanks!