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Jazz Networks: A proposal for deploying network services in the 6G cloud continuum

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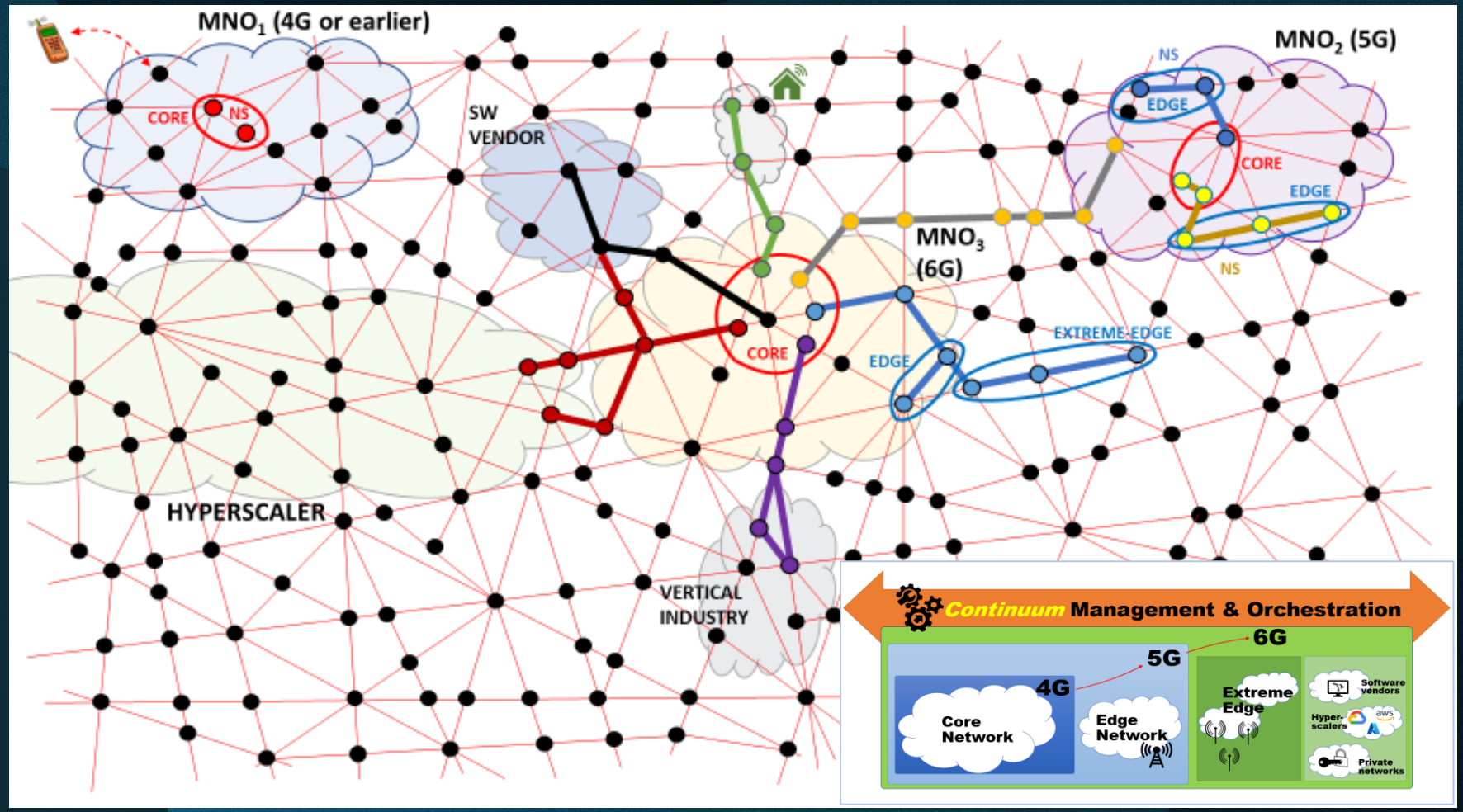
an atos business

Continuum management and orchestration towards 6G.

Network services expanding beyond the MNO boundaries.



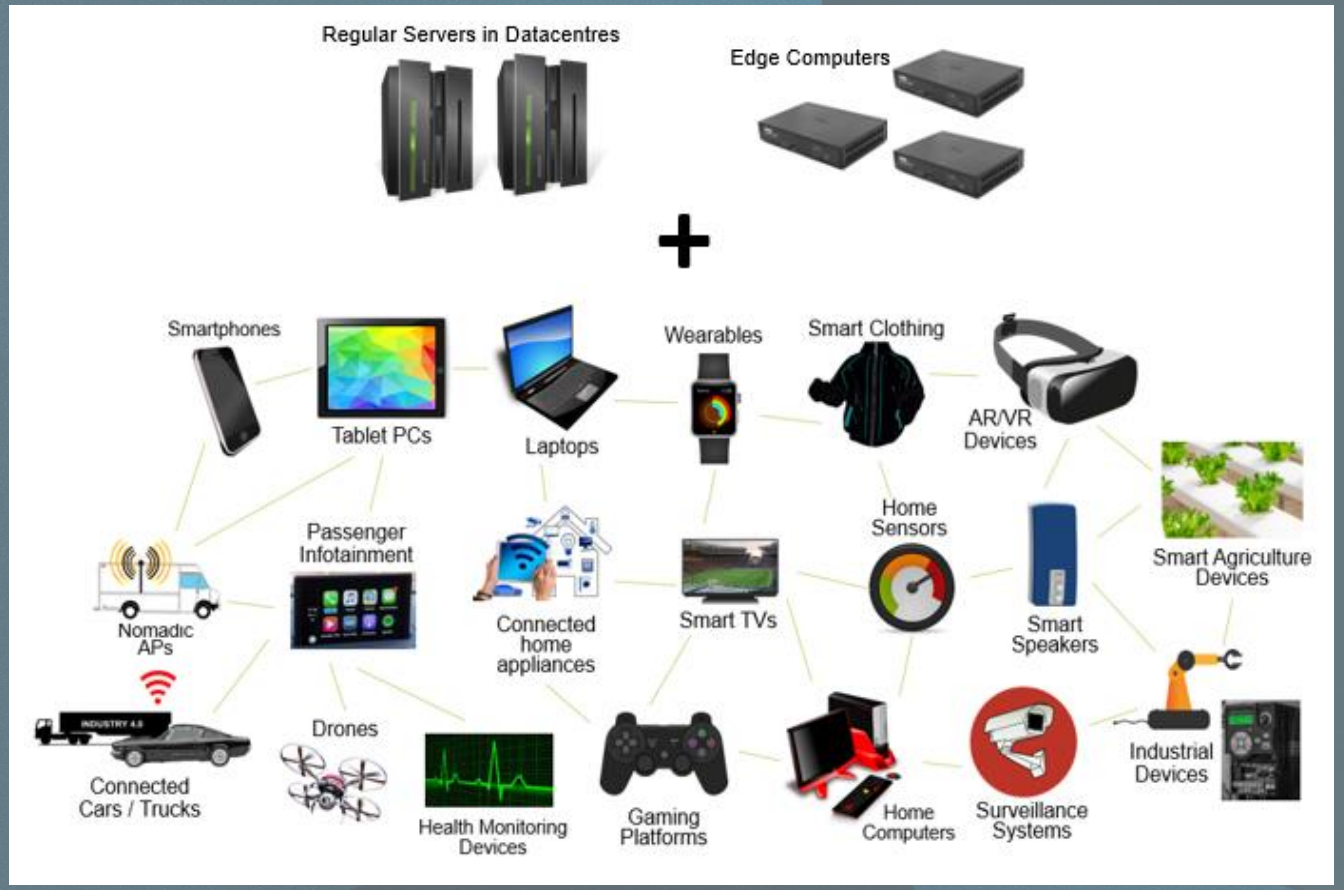
Network continuum: Heterogeneous set of network infrastructure resources (i.e., compute, interconnect, and storage resources), physical and/or virtualised, spanning across different technological and administrative domains, but exposed to the stakeholders as if they were a single integrated resource (aka *cloud continuum* or *device-edge-cloud continuum*).

The 6G Extreme-Edge.

Main features and challenges.

- Those resources in the Network Continuum **beyond** the technical and the administrative domains of a specific stakeholder, also part of that network continuum.
- It may include UE's, other Customer Premise Equipment's (CPEs), IoT devices, or external public or private networks.
- The infrastructure resources in this domain can be **highly heterogeneous**, **volatile**, **mobile**, and belonging to a **multiplicity of stakeholders**.
- The extreme-edge can also be **massive in scale**.

*All those devices are considered as an additional set of computing, networking, storage, and information resources **to orchestrate** service components on them.*



Example of Extreme-Edge devices

Tackling the challenge of integrating the Extreme-Edge

Jazz Networks design principles.

Network services assurance

Fully decentralised, relying on tailor-made, service-specific, M&O systems embedded as part of the network services themselves.

unbind

Network services provisioning

Fully decentralised, relying on multiple instances of a common reduced set of network elements, distributed through the entire network continuum.

Main Technical Enablers

Cloud-native

- SBA
- Light-weight micro-services
- Exposed interfaces
- Micro-services federation
- DevOps
- Large scale

Automation

- Leveraging on closed-loop and zero-touch solutions to reduce manual interventions.
- For both: resources (rel. to infrastructure discovery) and network services management.

AI/ML

- To deal with the complexity associated to integrate the huge, diverse, and highly elastic extreme-edge domain.
- To support intent-based operations.

DS Technologies

- Large scale distributed databases.
- Distributed computing models.
- Network crawlers (for the infrastructure discovery).
- MapReduce programming model.

Tackling the challenge of integrating the Extreme-Edge

Jazz Networks design principles.

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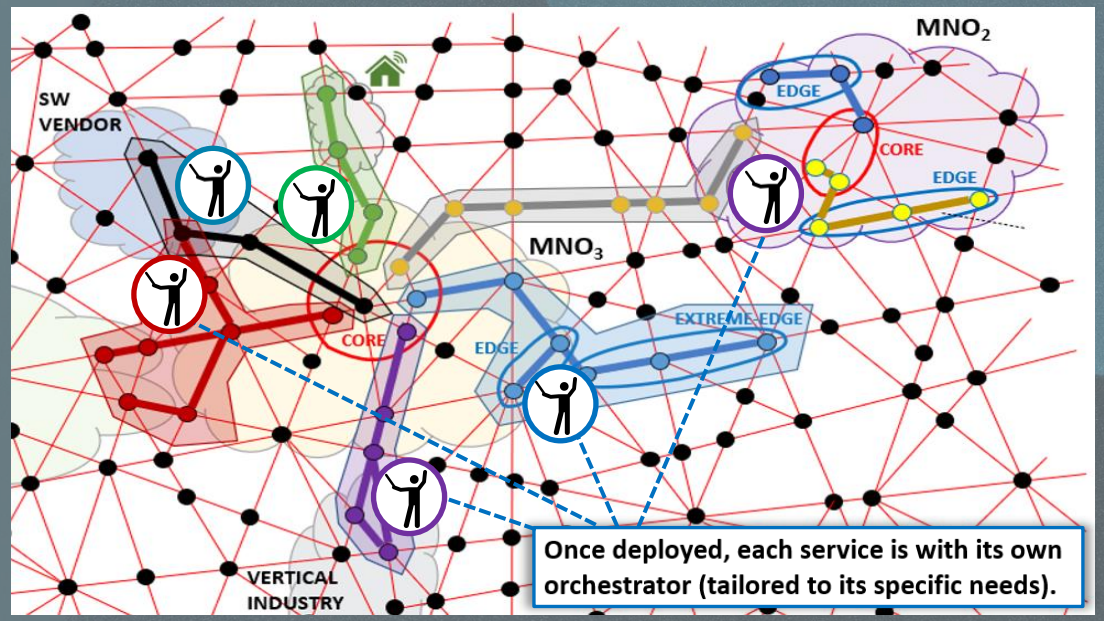

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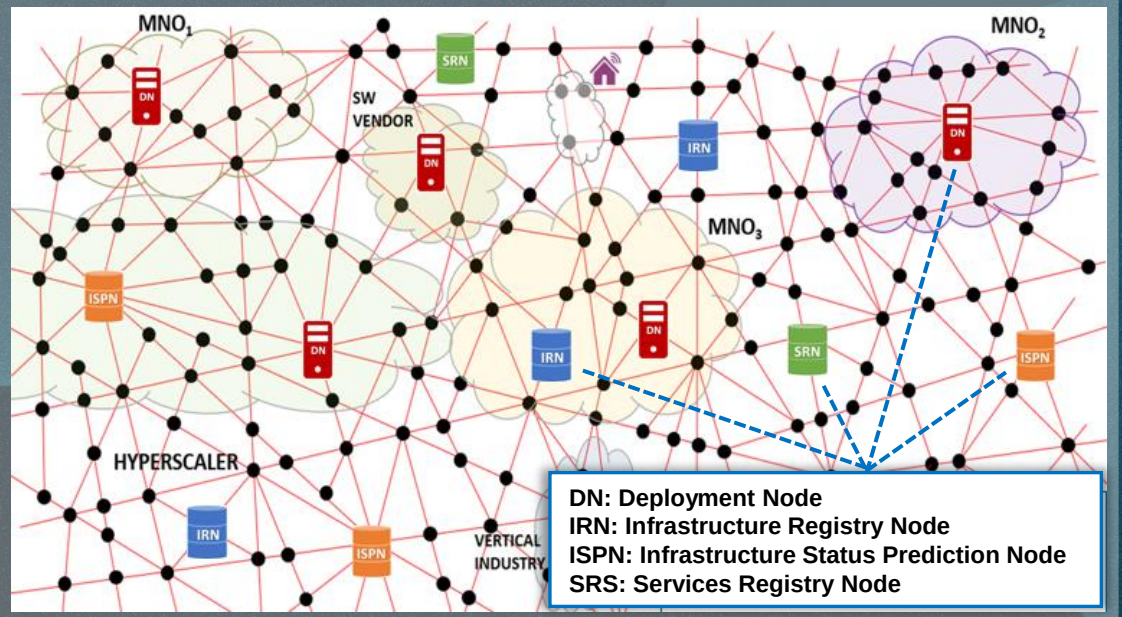
Network services provisioning

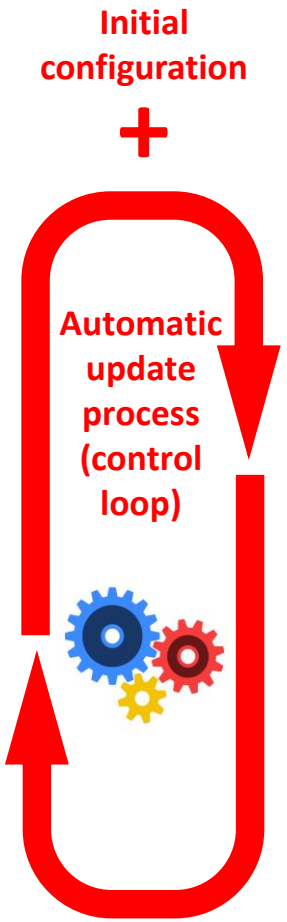
Fully decentralised, relying on multiple instances of a common reduced set of network elements, distributed through the entire network continuum.



Infrastructure Registry Service

Overview.

Field	Value
Device Id (handler)	Unique identifier for each device.
IP Address	IP Address
Device Type	Server, small scale computer, game console, industrial robot, vehicle... Also, if physical or virtualized.
Storage capacity	Storage capacity (x bytes)
Computing features	Number of processors, processing architecture (CPU, GPU, FPGA…), processing speed, etc…
Memory	Memory capacity
Network domain	Core, edge, extreme-edge (if applicable)
Owner	MNO, Vertical Industry, Third party network provider, end-user…
Power supply	UPS, main, battery powered… also, the kind of the energy sources when applicable - e.g., if we know the device is powered using renewable energies, NFs placement decisions could be taken based on that.
Reliability	Percentage. Computed based on the device actual behavior. Service placement decisions could be based on that.
Activity period	E.g., “24/7” or specific or specific time slots in which the device is known to be connected or disconnected (e.g., weekends/workdays, day/night, etc…).
Geographical location	Where the device is deployed (country, region… perhaps the ISD CC could be used).
Mobility info	If the device is mobile or static. If mobile, the geofence/heatmap where this device typically moves…
Status	Current status (on/off/standby…).
Available metrics	Metrics that could be useful for the service components to know (CPU level, RAM occupancy, network statistics…).
Networks	Networks to which the device is connected.
…	



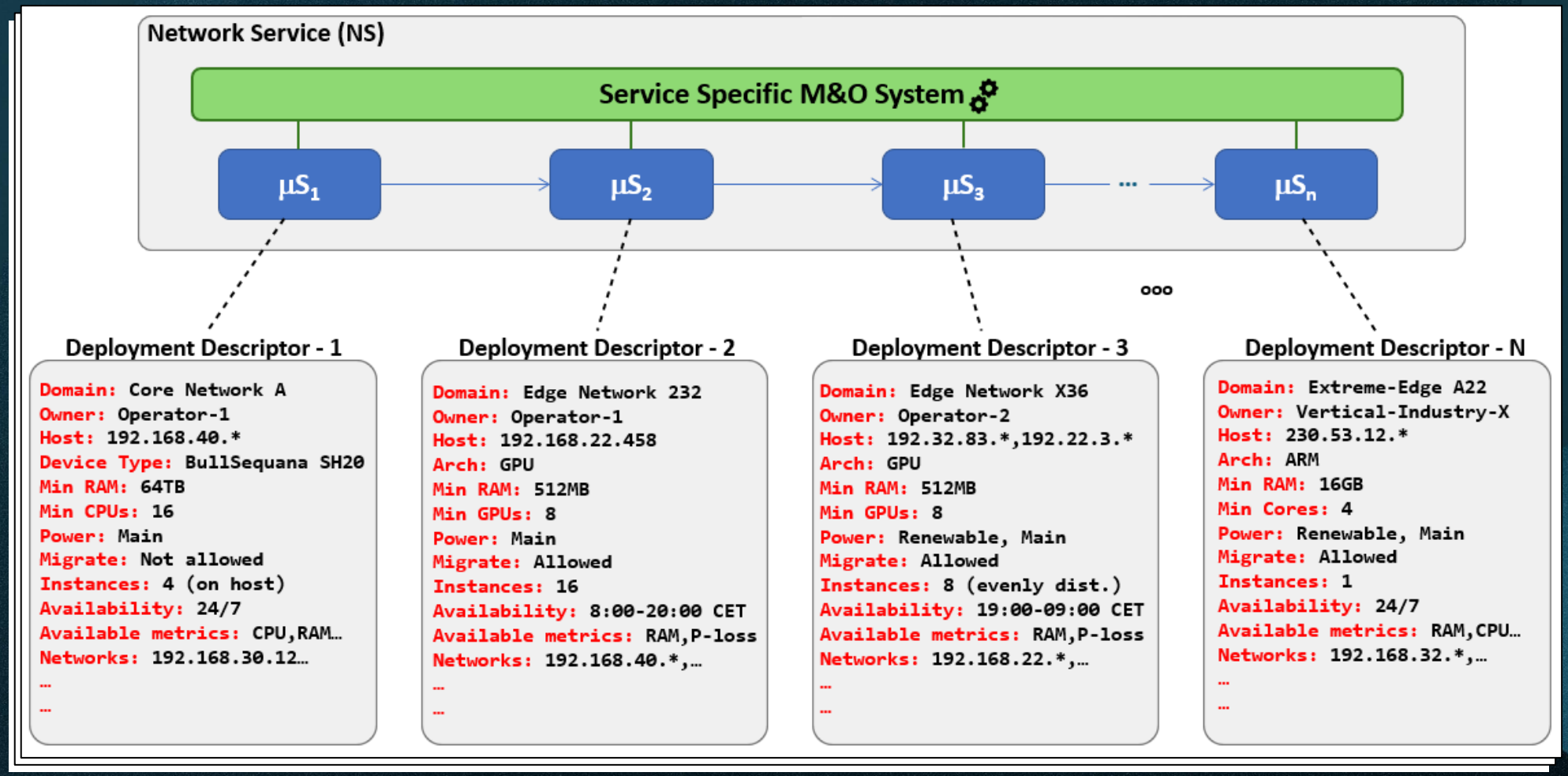
↪ Distributed database (DNS-like).

↪ Per-device registers according to an information model considering the specific resources features.

↪ Incorporates discovery mechanisms to dynamically update the stored information.

Deployment Service

Network Service definition example



Parameters in the IRS data model

IRS

↪ Network entry point for the Network Services.

↪ Relies on the information provided by the Infrastructure Registry Service (previous slide) for the deployment.

↪ The deployment would be intent-based.

Deployment Service
Idealised Front-end

Deployment Node – Service Creation

Search:

Multi-stakeholder Components Marketplace:

Own Components	MNO 1	MNO 2	Vertical Industry 1	Vertical Industry 2	AI/ML Provider
SF-DPI	NSSF	AF	GeoFunc	VehiclTrk	RLAgent
NA-QoS	NEF	AMF	RobotTrF	DronTrk	IntentF
SFF	AUSF	NWDAF	IoTGetF	QoE-F	SpeechR
Classifier	SMF	UPF	ProbCNF	GUI-GW	AnalyticF
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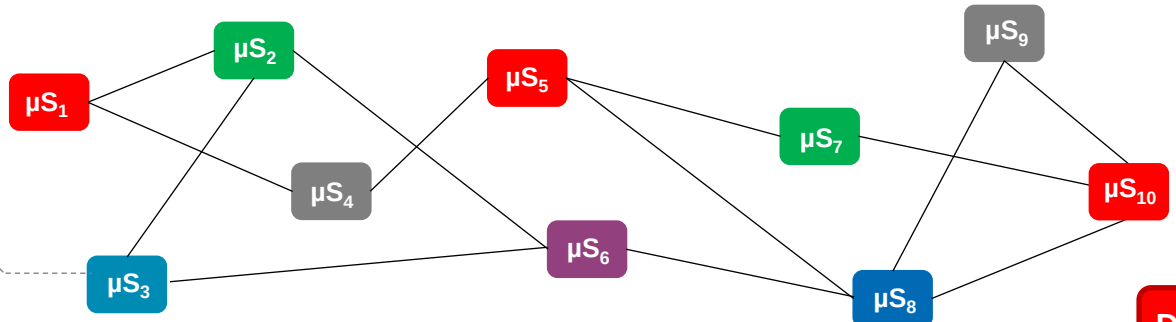
Intent-based Network Service Composition Dashboard:

Deployment Descriptor - 3

```
Domain: Extreme-Edge X36
Owner: Vertical-1
Host: 192.32.83.*,192.22.3.*
Arch: GPU
Min RAM: 512MB
Min GPUs: 8
Power: Wind, Solar, Other
Migrate: Allowed
Instances: 8 (evenly dist.)
Availability: 19:00-09:00 CET
Available metrics: RAM,P-loss
Networks: 192.168.22.*,…
…
…
```



DEPLOY NOW!

NL Intent-based Interface:

Please configure microservices 8 and 9 to be deployed on the Edge cluster CE35 belonging to MNO 2, but only on nodes powered with renewable energy.

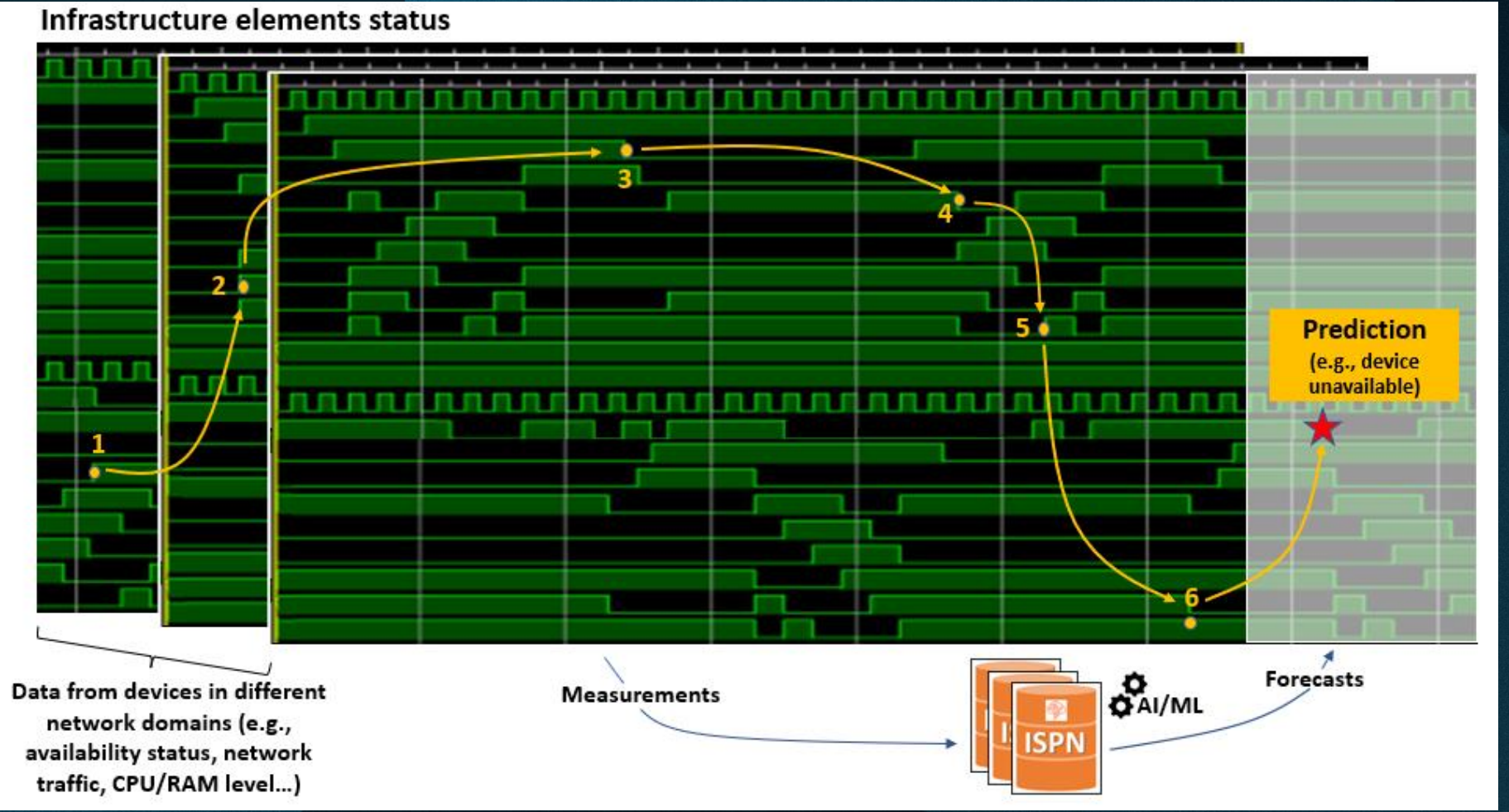
Done!

Please configure the AUSF function to be deployed always on the MNO-2 Edge nodes.

Sorry, that's not possible. That function requires high-capacity nodes in the core network.

Infrastructure Status Prediction Service

Overview



- Receiving [availability]* info from the infrastructure devices.
- Correlates intra- and inter-domain information to find out related events (which may not be evident) to produce reliable predictions about the [availability]* of the network resources.
- It could be queried during the NS deployment process to optimise the NS components placement.
- It would alert the IRS or the network services in case a resource (or set of resources) in use could become unavailable within a defined span of time (e.g., to scale or re-configure services already in operation).

[*] Or other relevant parameters.

Services Registry Service

Overview

- Distributed database to keep record of the current execution environment of all the network services deployed on the network.
- Given the high volatility of the Extreme-Edge domain, the components of a Network Service already deployed could be migrated from the nodes where they were initially deployed.
- Considering that, the SRS would provide a “stable anchor” to allow accessing the service even if it moves after its initial deployment.
- It would basically provide a “current service access endpoint” to the management interface of the node that should be used to access the service.
- It could also store information about the deployed network services (e.g., using an approach similar to the Network Service Descriptors data model in the ETSI NFV MANO specification).
- However, using this mechanism would be optional if at least one of the service components is deployed on a non-volatile node (e.g., on an MNO core network).

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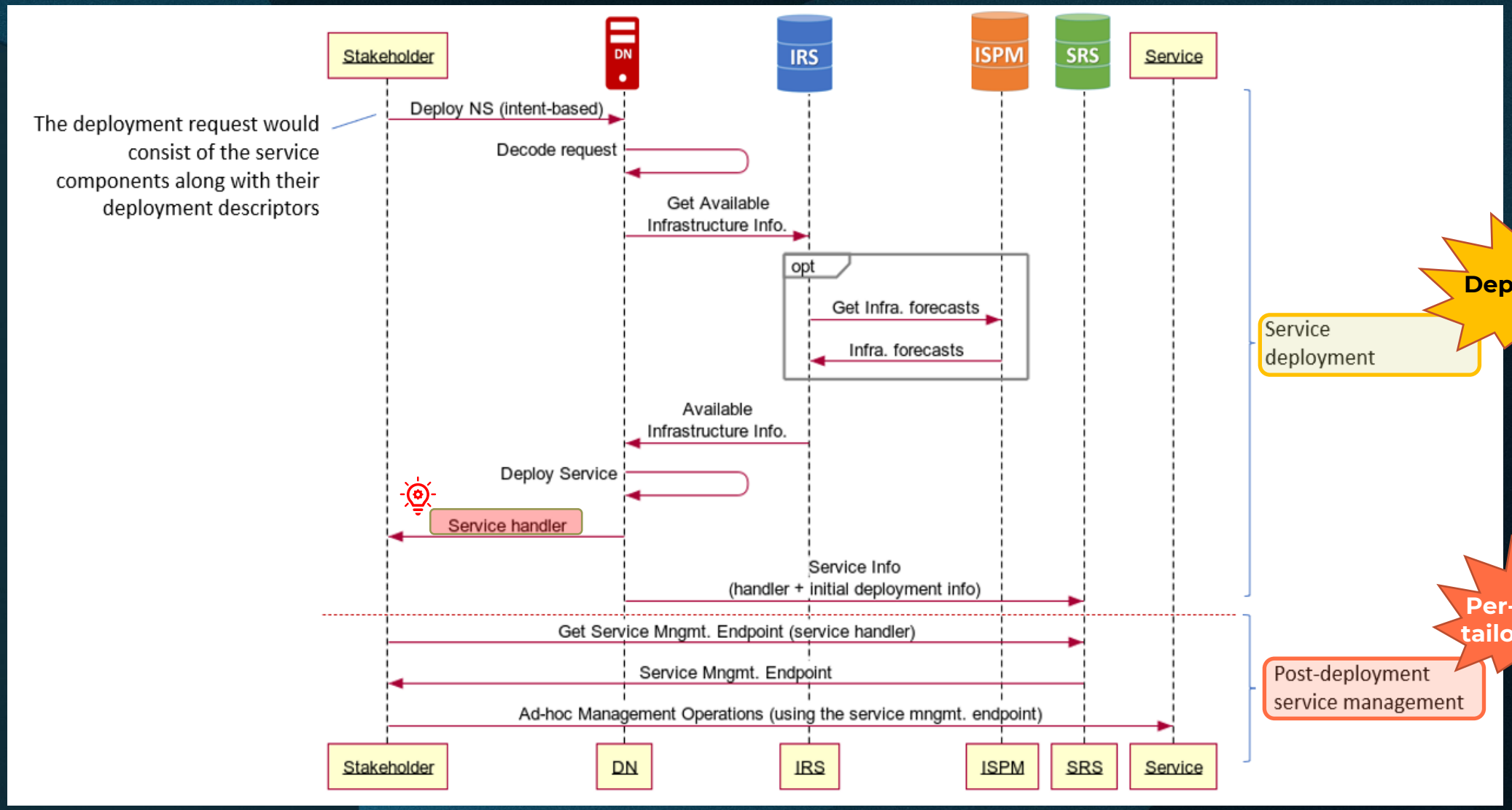
How all this would work together

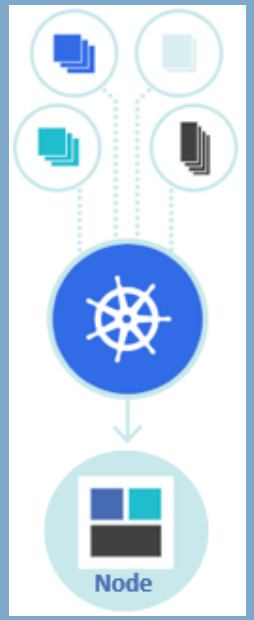


… which could mean minimalistic or even no-orchestration based design patterns.

Tailor-made M&O system for the Network Services

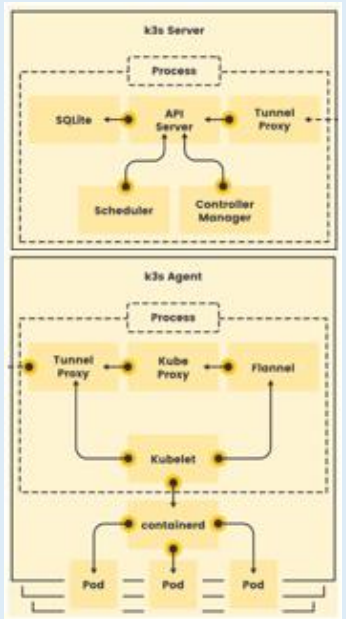
Implementation possibilities in the SotA

Service Assurance System for Service #1



kubernetes

Service Assurance System for Service #2



K3S

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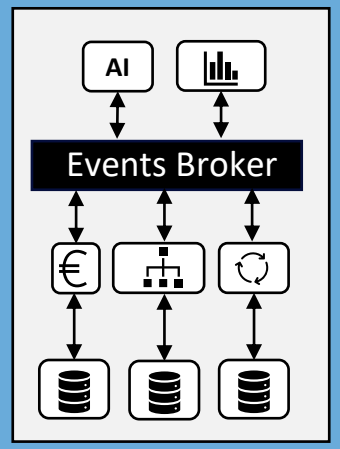
Service Assurance System for Service #n



Choreography

Other possibilities:

- Other containers orchestration systems:
  - Docker Swarm
  - Open Swift
  - Apache Mesos
  - Nomad
  - …
- Other lightweight containers orch. solutions:
  - MicroK8s
  - Kind
  - Minikube
  - …

➡ Proprietary (e.g., provided by verticals) orchestration solutions.

➡ Other future solutions.

Jazz Networks

Main features and benefits

#1 Highly scalable

- Distributed system, so inherently scalable.
- Designed to support a large number of resources and services.
- No SPOF.

#2 Resources optimization

- Per-service tailor-made orchestration mechanisms.
- Integrated intelligence enabling proactive orchestration mechanisms.
- Dynamic zero-touch resources discovery.

#3 Openness

- Able to integrate multi-technology non-owned resources in a multi-stakeholder environment.
- Less barriers to external parties (e.g., vertical industries or vendors) to integrate their specific HW and SW technological solutions.

#4 Reduced OPEX for MNOs

- Delegating the orchestration resources to the Network Services reduces the operational complexity in their own infrastructure.
- Certain services could be managed by other stakeholders, without the need for MNOs to be closely involved.

#5 Multi-domain by design

- Does not requires communication among MNO-centric orchestrators.
- Required communication would be simplified, being addressed at service level and from specific service components (micro-services federation).
- Reduces the need of complex business and technological agreements among different MNOs or other stakeholders (those agreements, when needed, would be per service component, i.e., less complex and in a more granular scale).

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Thank you!

Questions, comments...?

For more information please contact:
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The concepts presented here are being developed in the Hexa-X-II, 6G-EDGEDT, and 6GDAWN projects. The Hexa-X-II project has received funding from the Smart Networks and Services Joint Undertaking (SNS JU) under the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101095759. 6GDAWN and 6G-EDGEDT are funded by the Recovery, Transformation, and Resilience Plan of the Spanish Government via the UNICO I+D programme, and by the European Union's NextGenerationEU program.

Backup Slides

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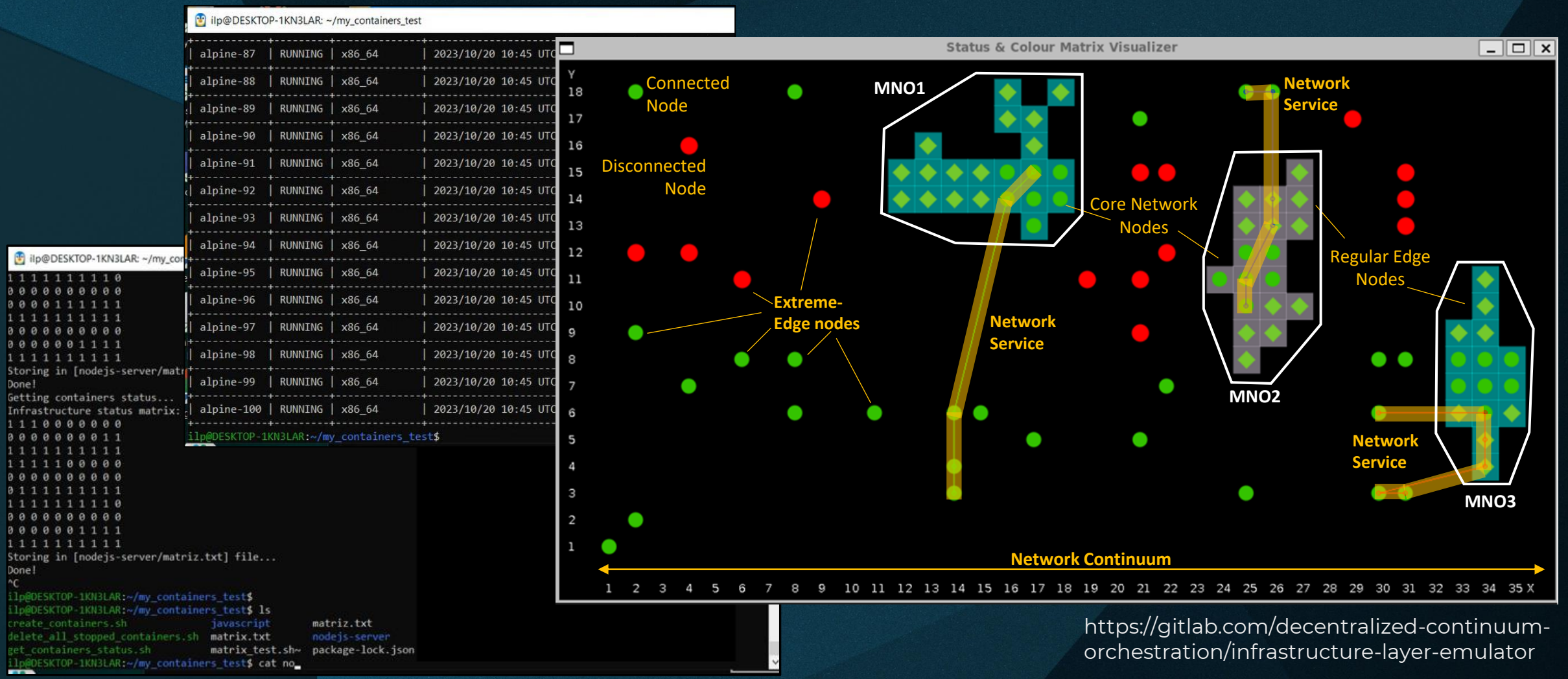
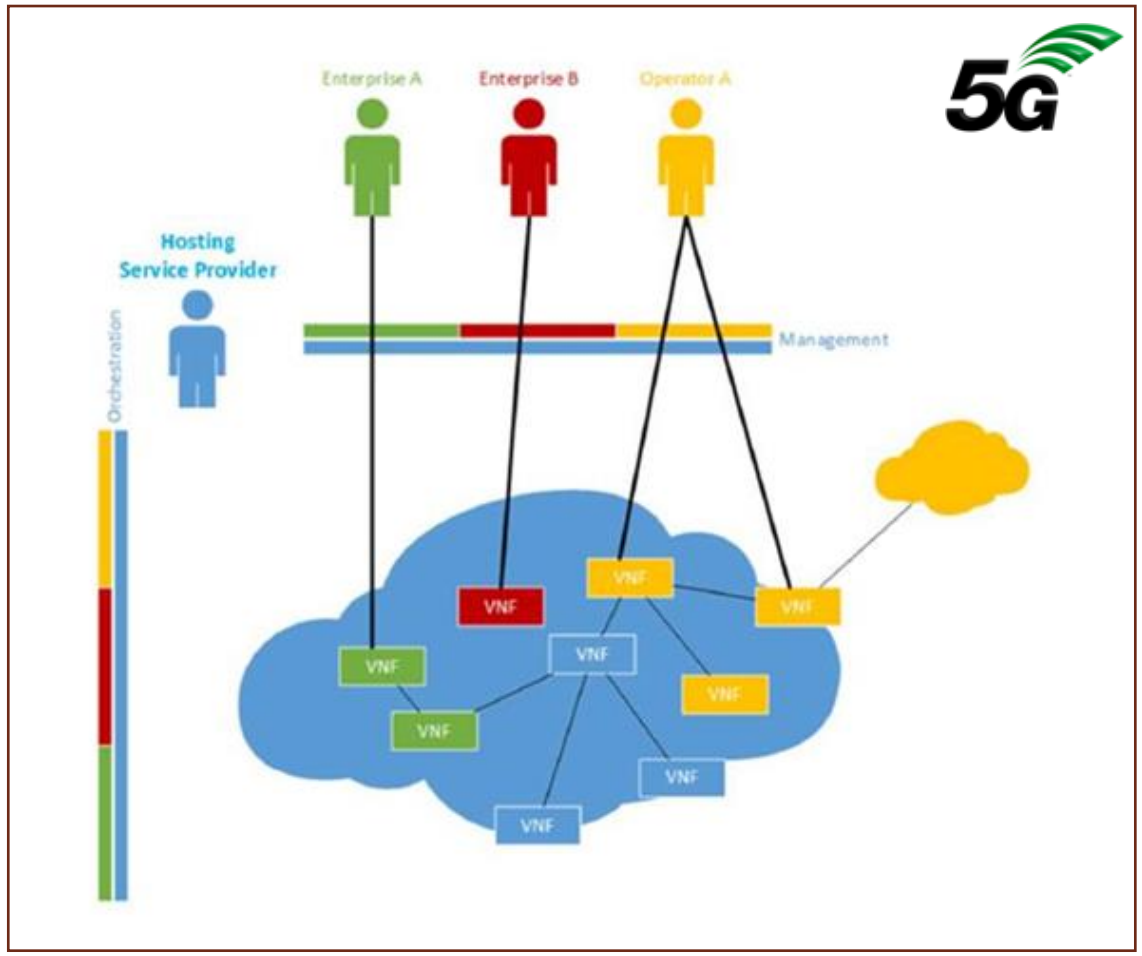


https://gitlab.com/decentralized-continuum-orchestration/infrastructure-layer-emulator

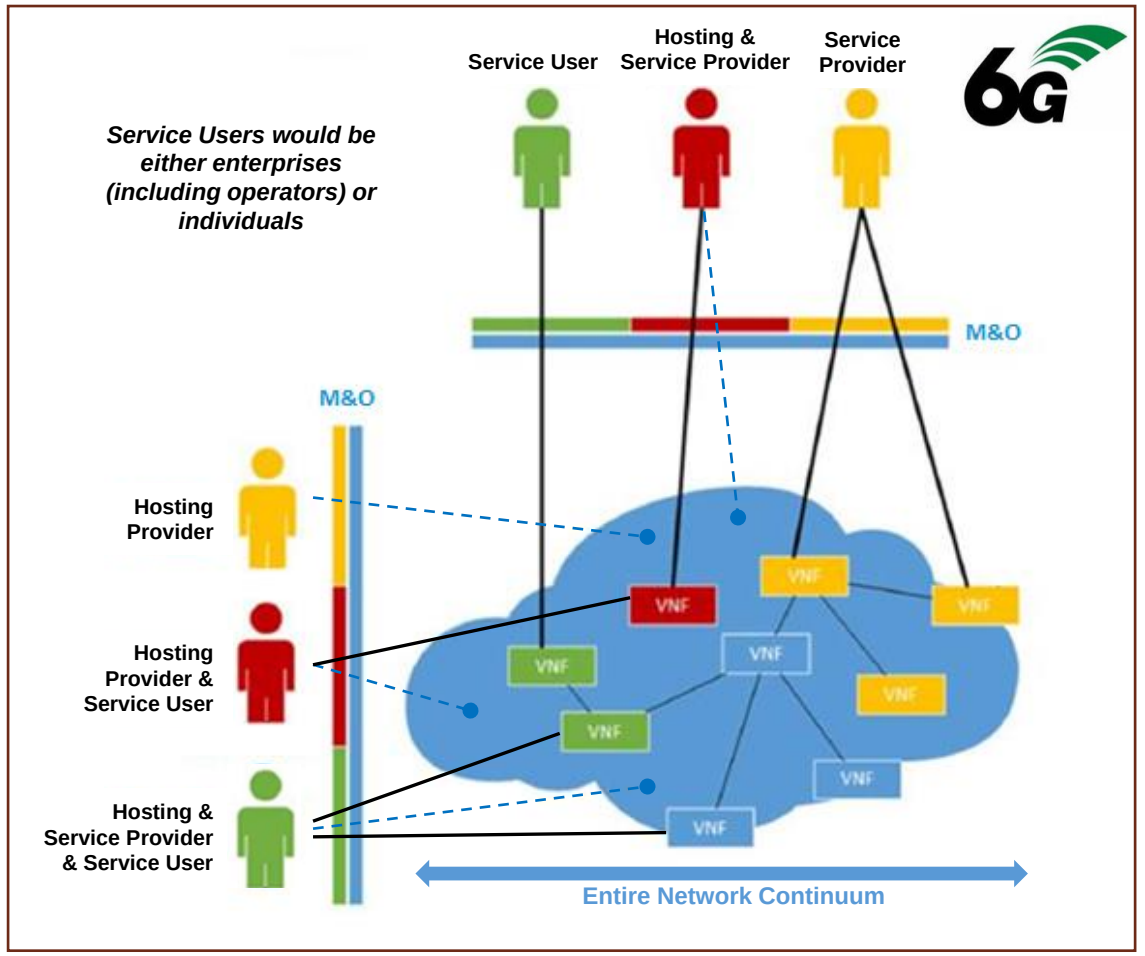
From 5G to 6G

Stakeholders and roles

Management and Orchestration view in 5G NORMA (Horizon 2020-ICT-2014-2 project)

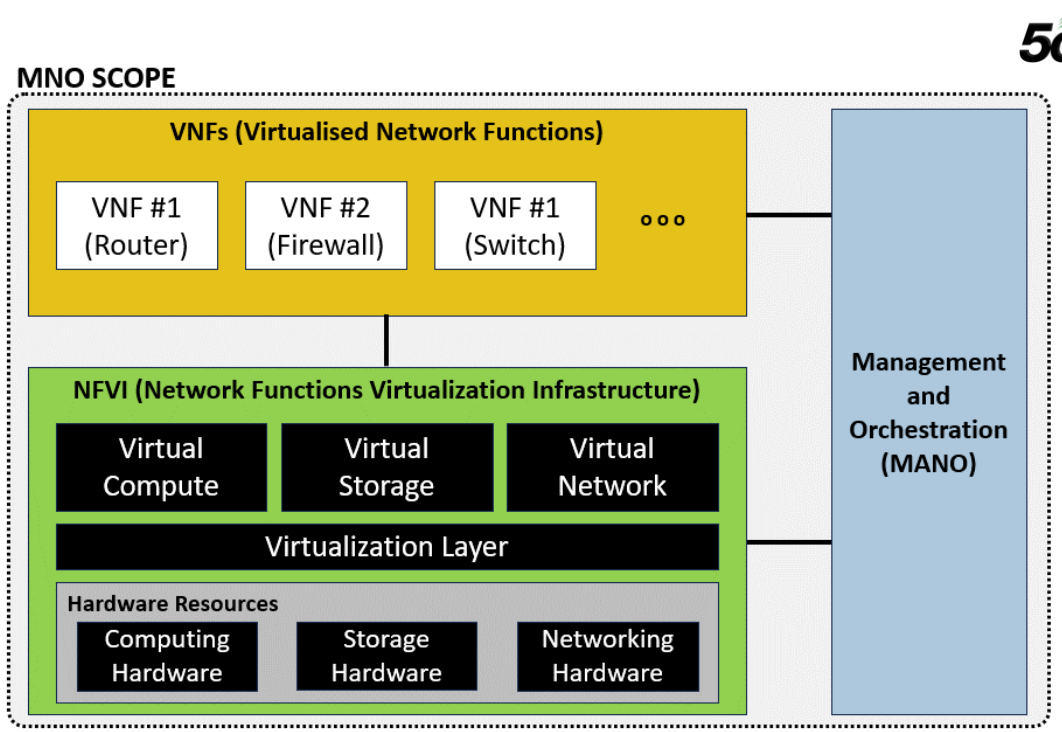


Management and Orchestration towards 6G



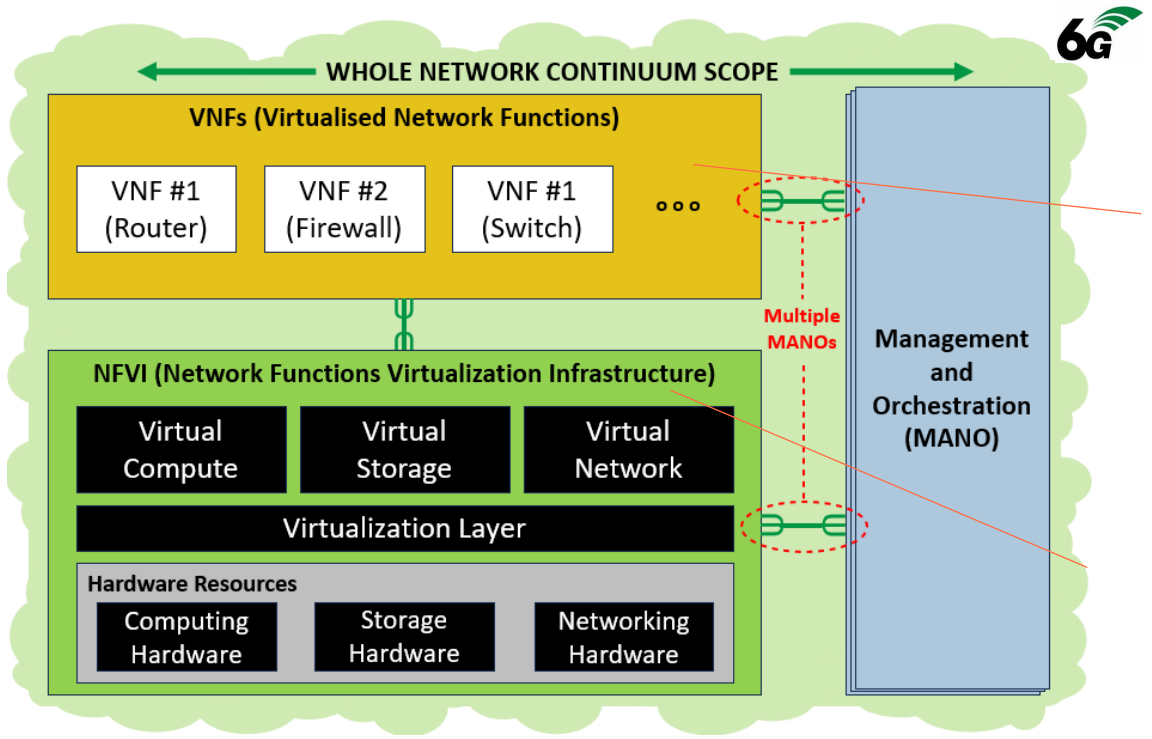
5G NORMA. Deliverable D3.2. 5G NORMA Network Architecture – Intermediate Report. Jan. 2017.

Alignment with the ETSI NFV MANO concept



Network Functions Virtualization. "SDN and OpenFlow World Congress", Frankfurt-Germany, October 15-17, **2013**

- **The design targets the mobile network operator (MNO) scope.**
- **VNFs formulated with VMs in mind (2013).**
- **Reference-point-based interfaces.**
- **Multi-domain requires MANO-to-MANO communication, relying on specific interfaces in the involved MANO platforms.**
- **VNFs primarily intended to implement common infrastructure devices (routers, firewalls, network switches…).**
- **Centralised per-operator MANO platform.**



- **The design targets the whole network continuum, including the extreme-edge. The MNO is still a privileged actor, but part of that continuum.**
- **VNFs primarily implemented through light-weight containers.**
- **SBA, relying on cloud native exposed interfaces.**
- **Multi-domain by design: service chaining through multiple domains relying on the service components exposed interfaces (μ-services federation).**
- **VNFs to implement common infrastructure devices, but service logic components as well.**
- **Distributed multi-stakeholder MANO resources.**