Orchestrate day-to-day operations based on a single source of truth

The case of GP4L

Prof. Sonja Filiposka (UKIM), Roman Łapacz (PSNC)

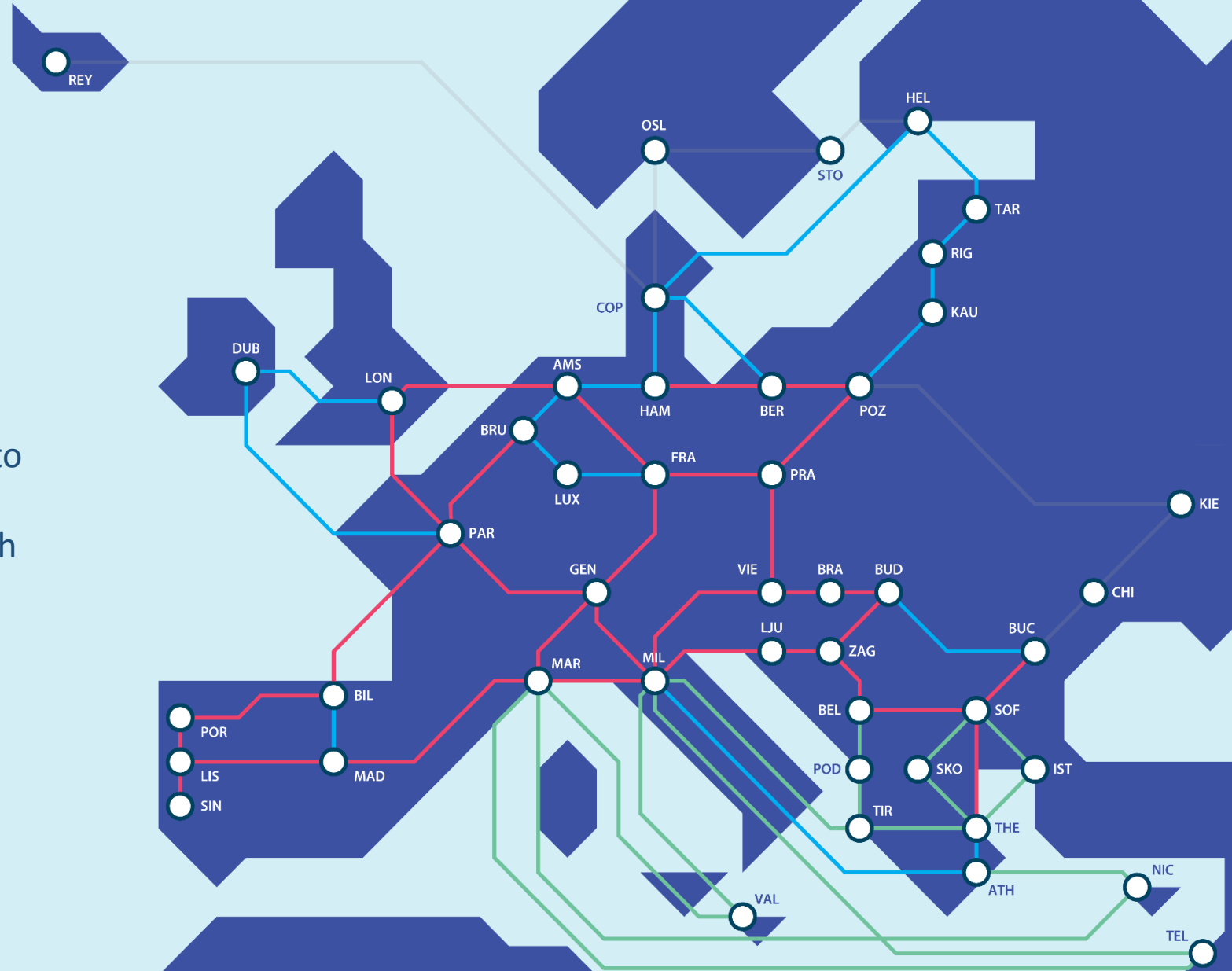RIPE NCC, Athens, Greece

22-23 April 2024

GN5-1

Agenda

- GÉANT
- The Global Platform for Labs (GP4L)
- Automation and Orchestration in GP4L
  - Components
  - Use cases
  - Service provisioning pilot
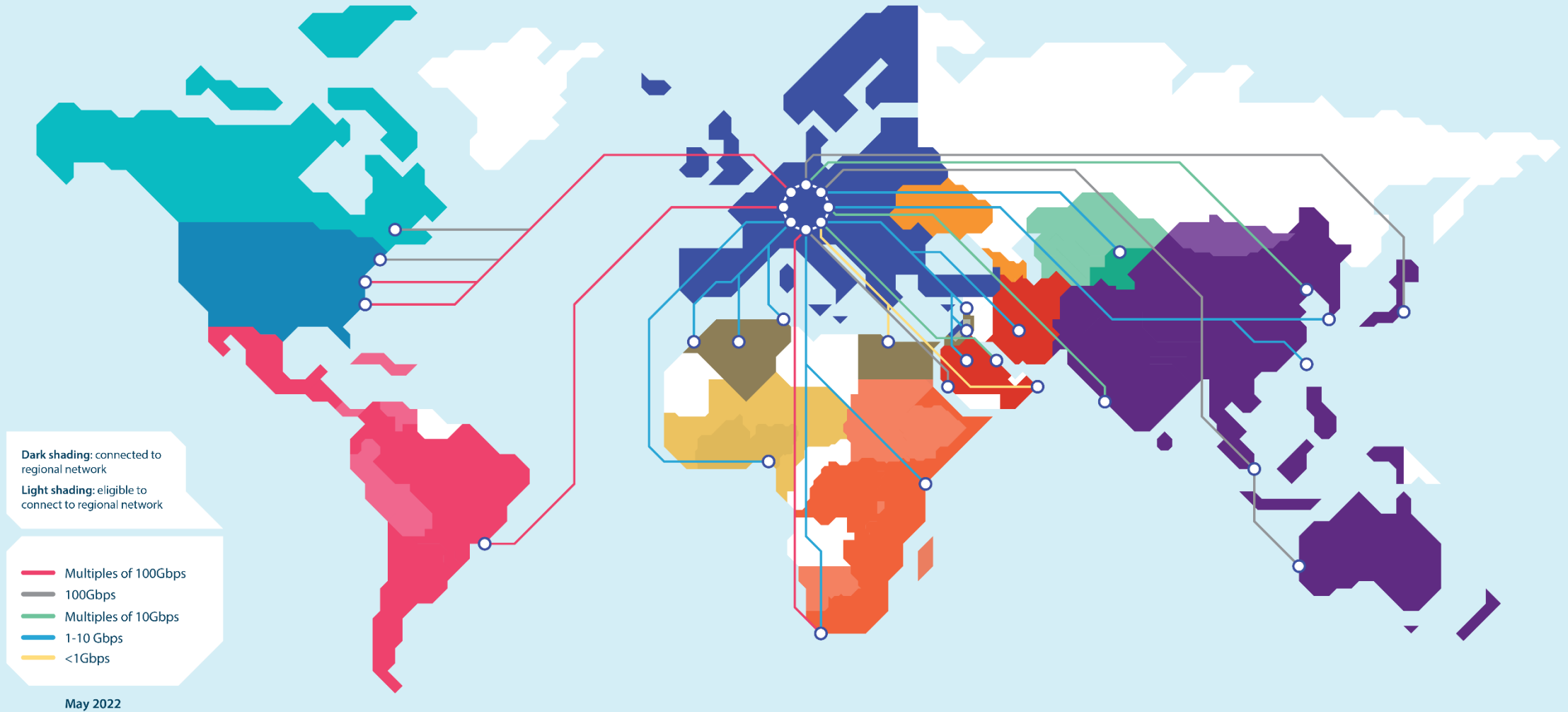 - Future work

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GÉANT Network

The GÉANT network interconnects research, education and innovation communities worldwide, with secure, high-capacity networks.

We design, plan, build and operate the large-scale, high-performance GÉANT network that connects European NRENs to each other and the rest of the world for sharing, accessing and processing the high data volumes generated by research and education communities and for testing innovative technologies and concepts.

At the heart of global research and education networking

Dark shading: connected to regional network

Light shading: eligible to connect to regional network

— Multiples of 100Gbps
— 100Gbps
— Multiples of 10Gbps
— 1-10 Gbps
— <1Gbps

May 2022

GÉANT

The Global Platform for Labs (GP4L)

1 GP4L infarstructure for experiments

2 GP4L pilots of network orchestration and automation

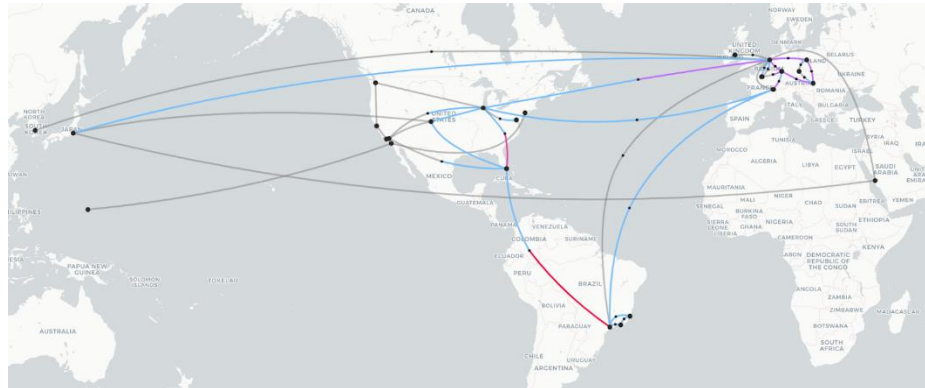https://wiki.geant.org/display/GP4L/Home

GP4L experiments ①

A programmable network infrastructure for the GÉANT community to run experiments of cutting-edge network technologies.
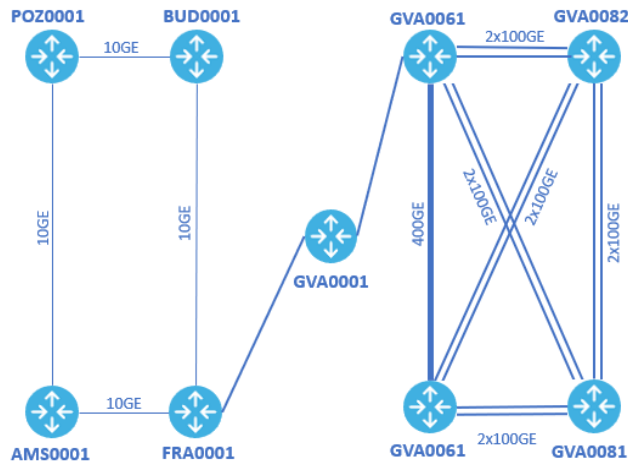
GÉANT Core & Community

id	node	institution	country	id	node	institution	country
1	ams0001	GEANT	NL	23	bna0021	Tennessee Tech	US
2	fra0001	GEANT	DE	24	CJJ0001	KISTI	KR
3	bud0001	GEANT	HU	25	jed0101	KAUST	UAE
4	poz0001	GEANT	PL	26	hnd0001	KDDI	JP
5	bud0002	MC36	HU	27	gva0061	GEANT	CH
6	par0001	RENATER	FR	28	gva0062	GEANT	CH
7	gva0001	SWITCH	CH	29	gva0081	GEANT	CH
8	chi0041	STARLIGHT	US	30	gva0082	GEANT	CH
9	tcd0021	Trinity College of Dublin	IR	31	umu0001	University of Murcia	ES
10	par0101	GEANT	FR	32	bio0001	University of Pays Basques	ES
11	rio0021	RNP	BR	33	bio0071	University of Pays Basques	ES
12	pra0101	GEANT	CZ	34	hnd0101	KDDI	JP
13	e513-e-yecwh-1	CERN	CH	35	ams0002	University of Amsterdam	NL
14	bur0051	CALTECH	US	36	san0111	San Diego Supercomputer Center	US
15	mia0001	AM-Light	US	37	gum0111	University of GUAM	US
16	sao0021	RNP	BR	38	nyc0111	NYSERNet	US
17	vit0071	UFES	BR	39	chi0111	Pacific Wave	US
18	dub0021	HEANET	IR	40	mia0101	Florida International University	US
19	bwi0001	University of Maryland	US	41	cph0021	Technical University of Denmark	DK
20	bur0001	CALTECH	US	42	lax0111	CENIC - Los Angeles	US
21	bur0002	CALTECH	US	43	sjc0111	CENIC - Sunnyvale -	US
22	bur0061	CALTECH	US	44	sea0111	CENIC - Seattle	US

GP4L pilots – towards digital platforms   **2**

GP4L as a playground for the work on solutions to orchestrate and automate network operations.

- Digital twin (containerlab)

- Orchestrated and automated network service provisioning (orchestrators, Ansible, SSoT, scheduling, monitoring, backup)

- Network visualization

- Network management in the Cloud (nmaas vNOC)   **NMaaS**

- Education (Network Automation eAcademy)

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Orchestration and automation components

- Orchestrator for workflow management
  - Service lifecycle management modeled as processes
  - APIs for integrating/calling independent tools

- Automation tools
  - Network configuration with Ansible

- Source of Truth
  - Desired state of the network

- Pre-production tests in the virtual twin
  - Verification of network configuration

Source of Truth (SoT) for orchestrated services
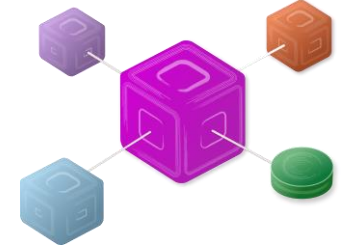
- Represents the desired state of the network - declarative approach

- The correct state given in the Single Source of Truth must be mirrored across the infrastructure

- An essential element of Infrastructure as Code (IaC) that facilitates the management and provisioning of infrastructure via code rather than manual procedures

Maat as SoT

Maat is a microservice for open digital platforms that serves as a single source of truth for physical and logical resources and/or services.

Open standard-based API	Extensible data model	Event notifications	Technology stack

Open standard-based API

- Full CRUD support offers automation and orchestration implementation out of the box
- AuthN with OAuthN 2.0
- TMF638 Service management REST API
- TMF639 Resource management REST API

Extensible data model

- JSON-based data model for resources and services
- Request validation based on data model schema file
- Data model extensions do not require changes in the application code or in the database
- Support for multiple data models defined in schema files provided by the user

Event notifications
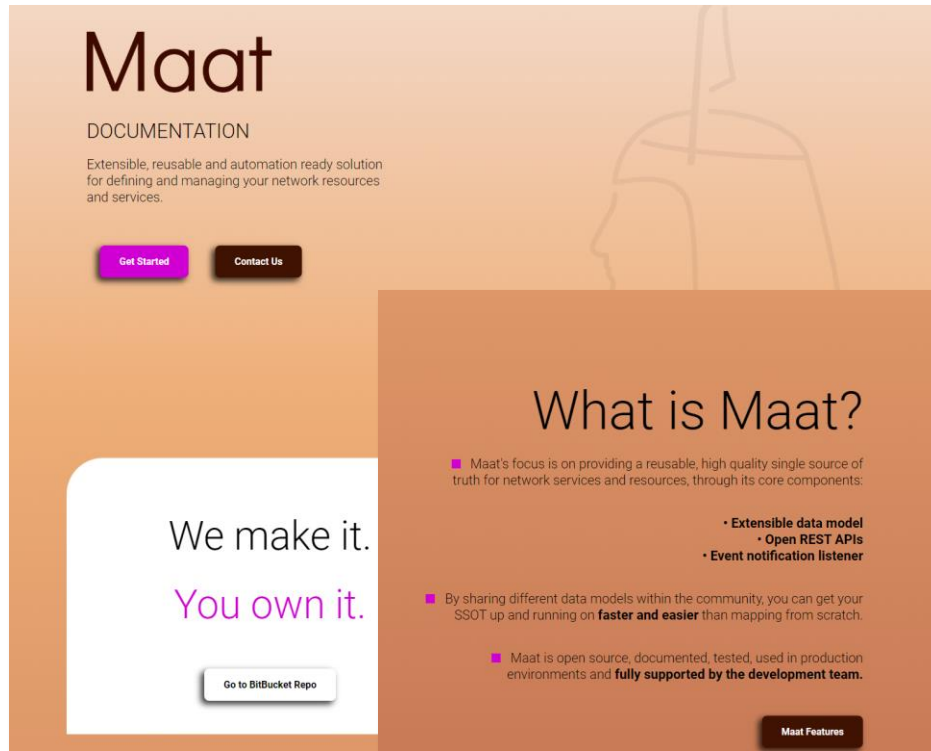
- External applications can register and listen to selected inventory events
- Events can be archived (EventListener)
- TMF standard API

Technology stack

- NoSQL database (MongoDB)
- Spring Boot 3 library
- Docker
- Keycloak

Maat as SoT

https://geant-netdev.gitlab-pages.pcss.pl/MaatDocs/

Digital twin for automation

CONTAINERlab

Digital twin is a virtual copy of the network infrastructure tha can be used for testing network configuration changes before the implementation in the production network.

- Use of containerlab to create a digital twin

- Wide range of virtual routers and Network Operation Systems

- Integration with Source of Truth (NetBox)
  - Netreplica provides nrx software to export a network topology from NetBox which next can be used by containerlab

https://github.com/srl-labs/containerlab

https://github.com/netreplica/nrx
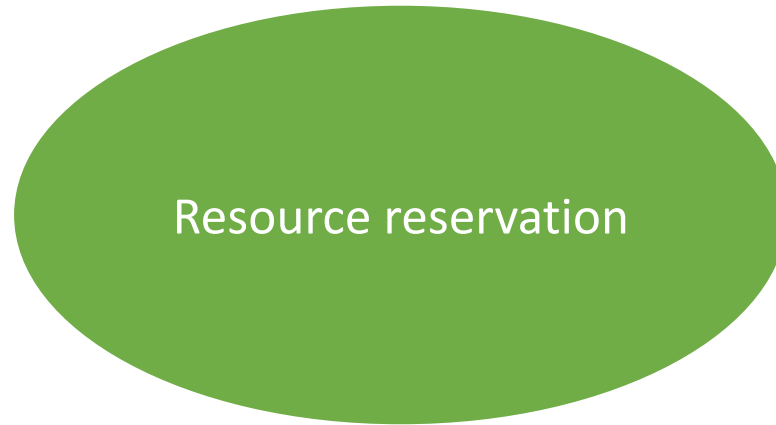
https://github.com/netbox-community/netbox

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GP4L operations use cases

Resource management

Resource reservation

Resource management use case

A GP4L partner connects a new programmable switch to the GP4L infrastructure.
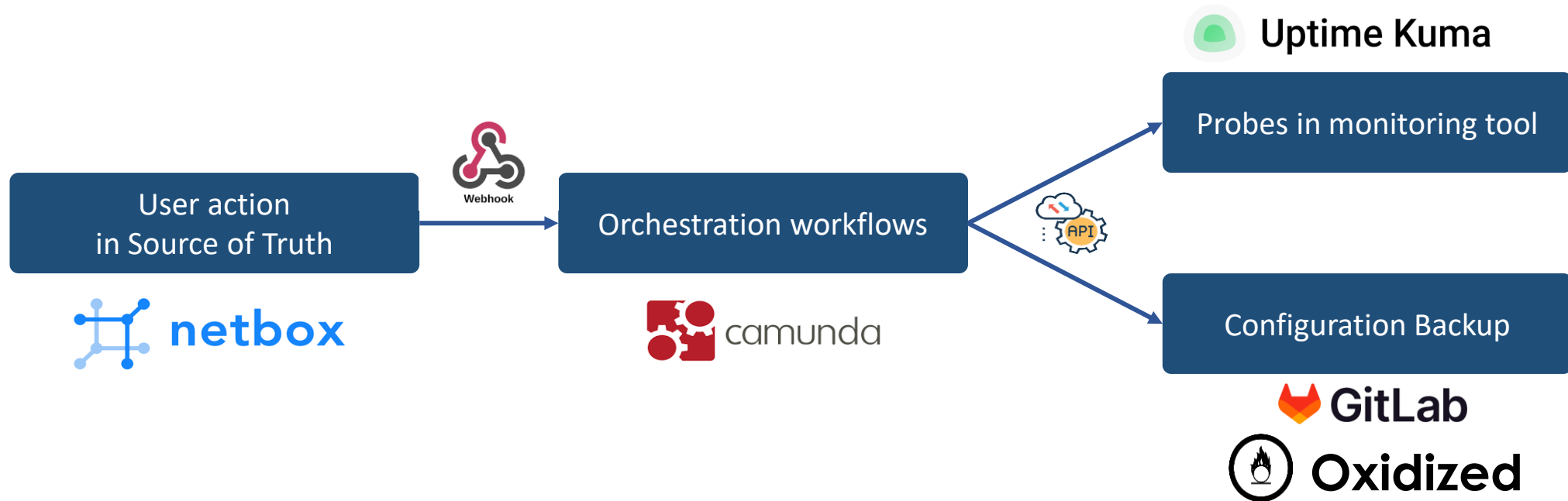
Experiment reservation use case

A resercher schedules an experiment in the GP4L infastructure.

# NetBox – a key Source of Truth component

Synchronisation with UptimeKuma (monitoring), Oxidized (backup) and scheduling (LibreBooking)

nmaas – virtual environment for orchestrated operations

NMaaS

> nmaas is a multi-tenant platform for effortless, on-demand deployment of software tools and applications.

- Virtual enviornment based on the Kubernates cluster

- The open platform software and the GÉANT production service

- Application catalog

- GP4L use cases implemented in nmaas
  - VirtualNOC
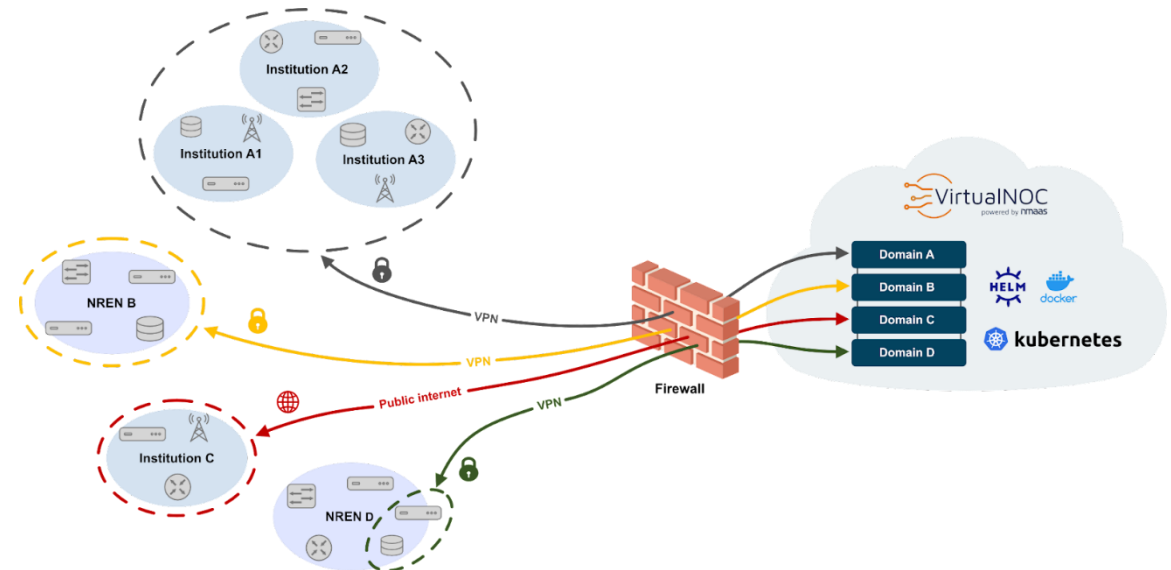
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GP4L as a testbed for orchestration & automation solutions
Service Provisioning pilot

Development of network service provisioning

- Workflow definitions for network services

- Data model representing resources and network services

- Selection of technology stack (open source)

- Reusable components (identification of elements which could be reused by different implementations of network service provisioning)

- A pilot for Polish National Research and Education Network PIONIER

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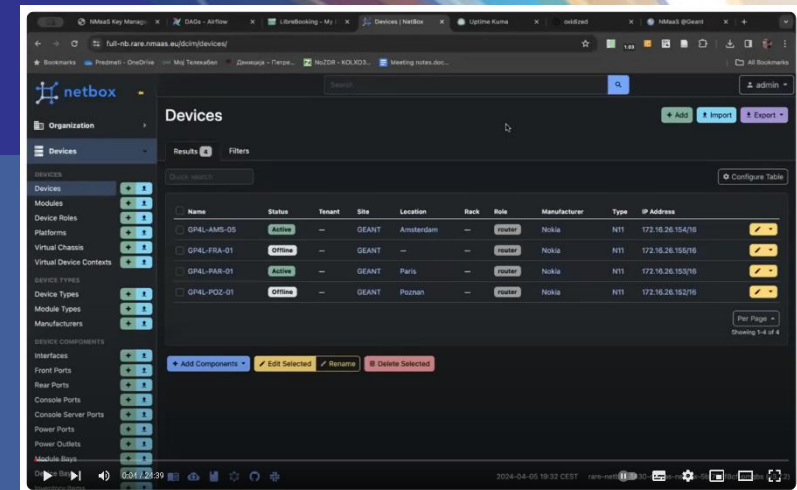 - Future work

Future work

- Development of orchestrated services in GP4L

- Continuation of development and tests of orchestrated services for PIONIER

- Testing various automation and orchestration technologies

- Knowledge sharing via eAcademy learning units

Thank You

Demo video:
    https://www.youtube.com/watch?v=KYqpLPBDR3k