

Knowledge sharing and monitoring for research and education

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Jisc

Workshop

_2025

Network Development at the GÉANT Project, GN5-2



www.geant.org



Co-funded by
the European Union

GÉANT Project

The collaboration of European National Research and Education Networks (NRENs) and European Commission.

The project's mission is to provide secure access to scientists, researchers and students to the world's most advanced connectivity and collaboration services, enabling effective and secure collaboration within virtual research communities around the world.

38 Partners

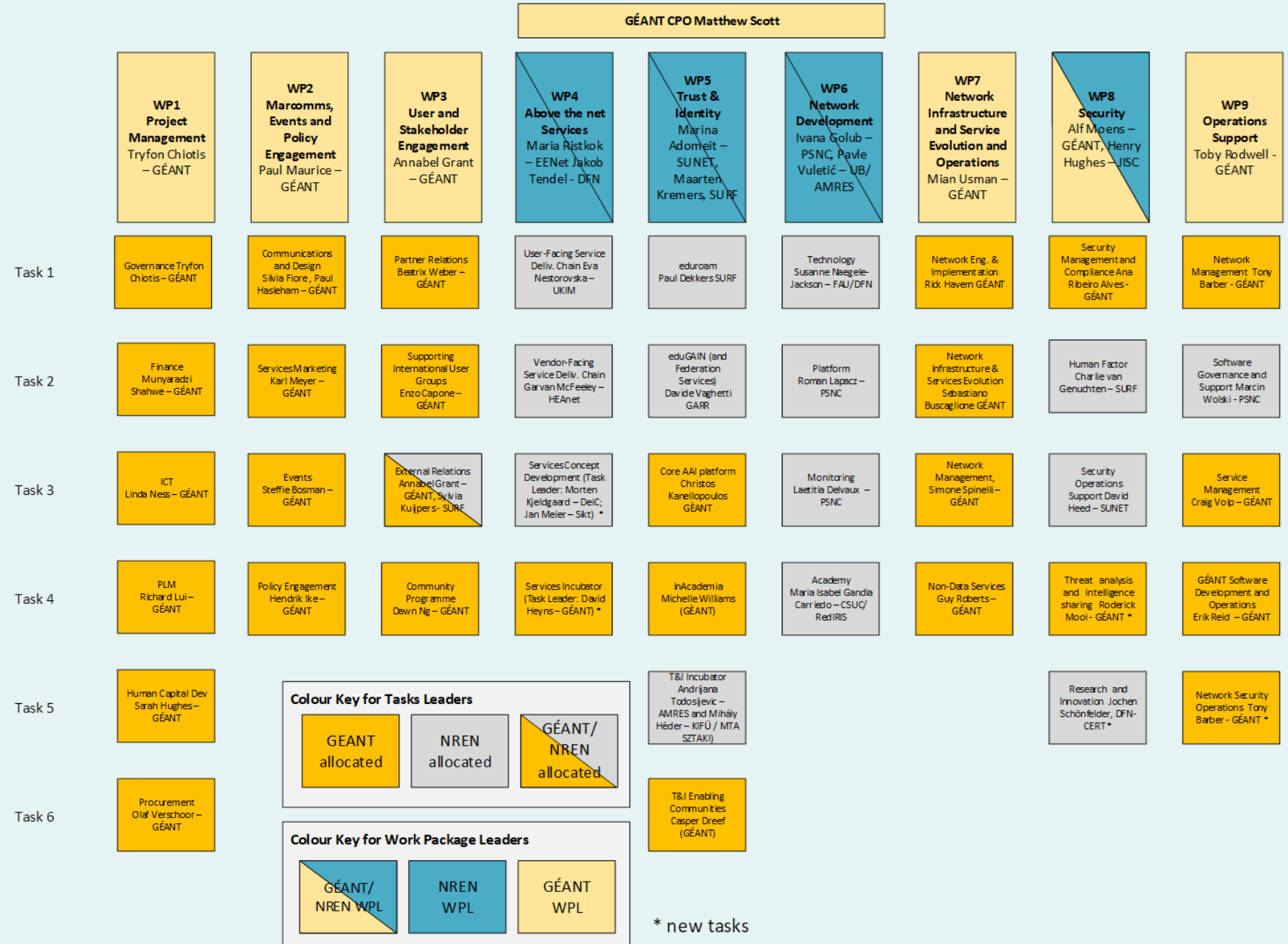
1 Associated partner

43 Countries

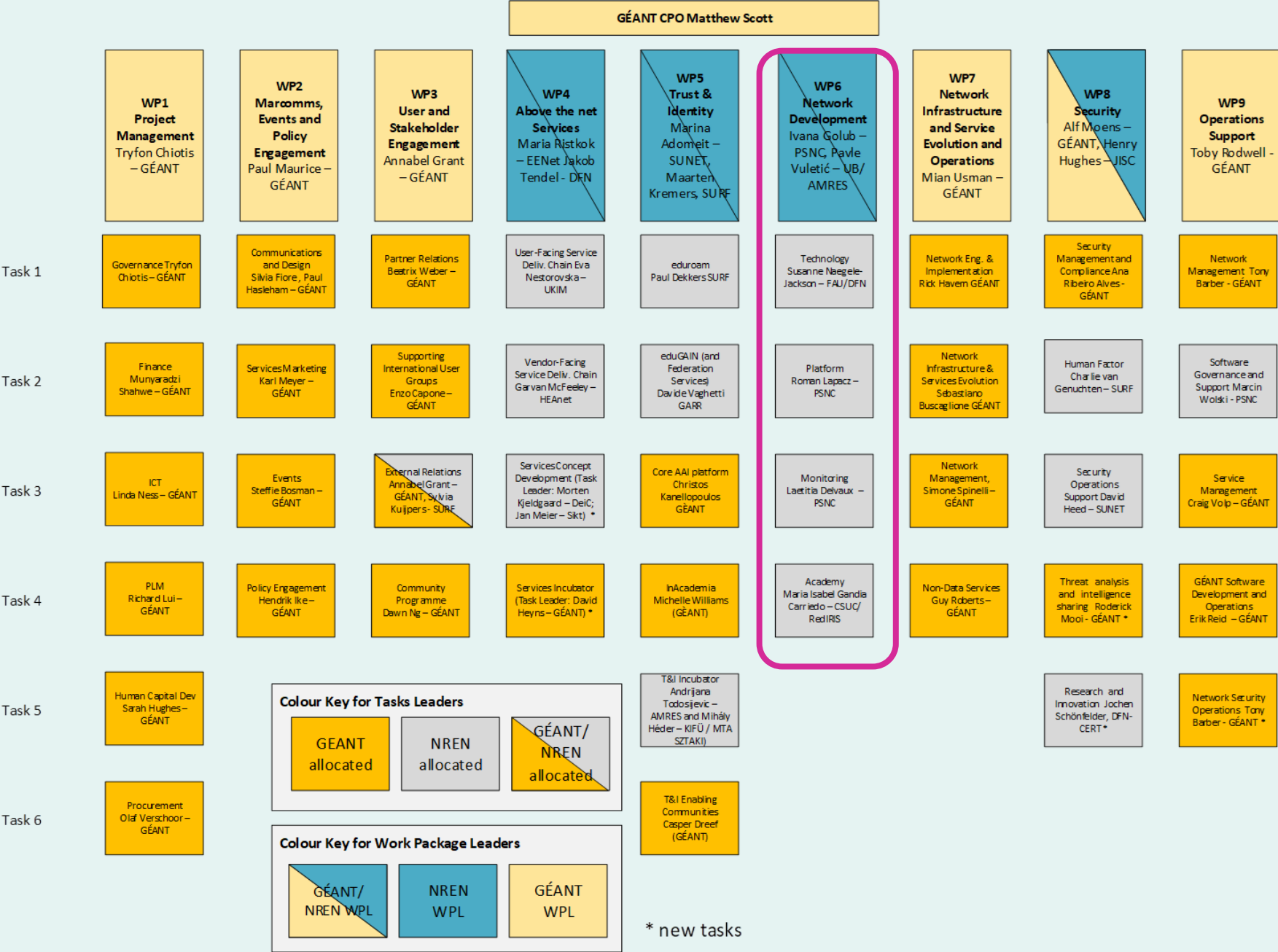
80 Mil EUR Budget

9 Projects - Work Packages

GN5-2 Project Structure



GN5-2 Project Structure: NETDEV



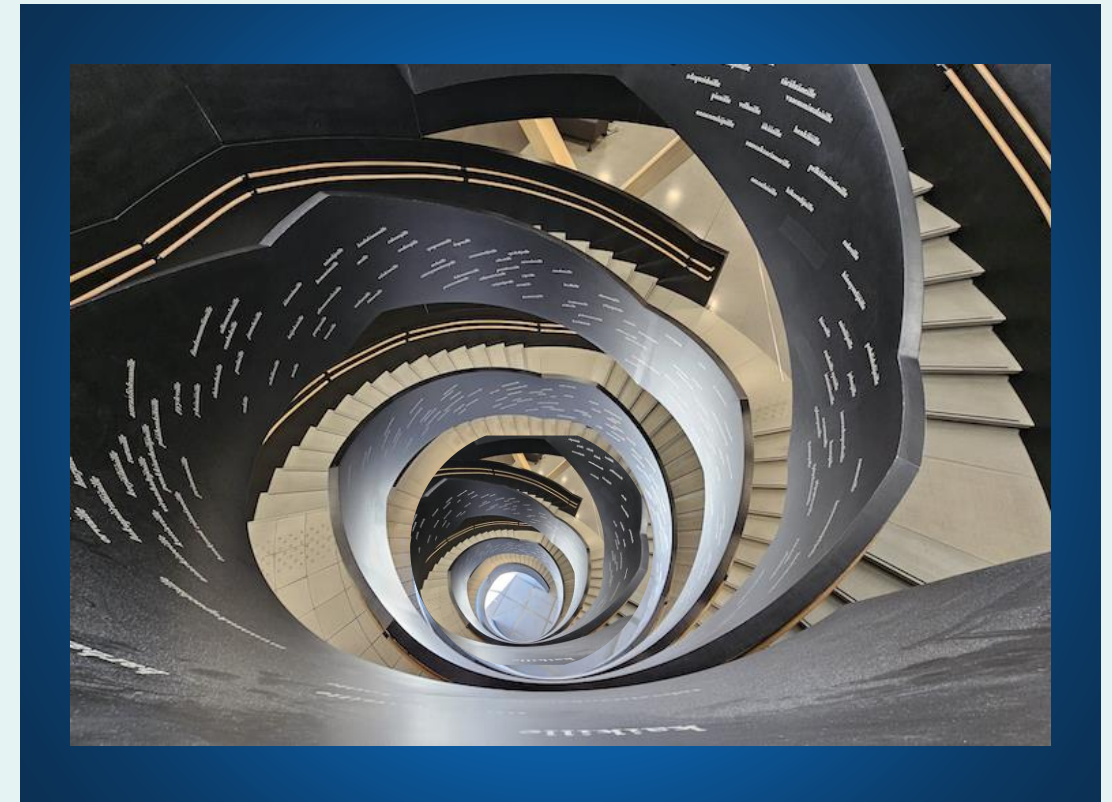
Network Development WP Objective

Undertaking **technology evaluation** and **testing, prototyping** and **development** to **support** evolution and enhancement of **NREN network infrastructures and services** in the areas of

- Network infrastructure and services
- Network monitoring and management

Exploring how emerging technologies can be applied for the GÉANT community

Enhancing GÉANT and NREN knowledge transfer through dissemination activities



NETDEV in a Nutshell

Why

Advancement of
GÉANT community network
infrastructure and services

25 organisations

How

Testing, piloting, product
and service development

Production services

Incubator

Partners' collaboration

>100 persons

What

Technologies,
Platforms,
Monitoring,
eAcademy

20+ topics

5,6 MEUR

28,1 FTE

Network eAcademy

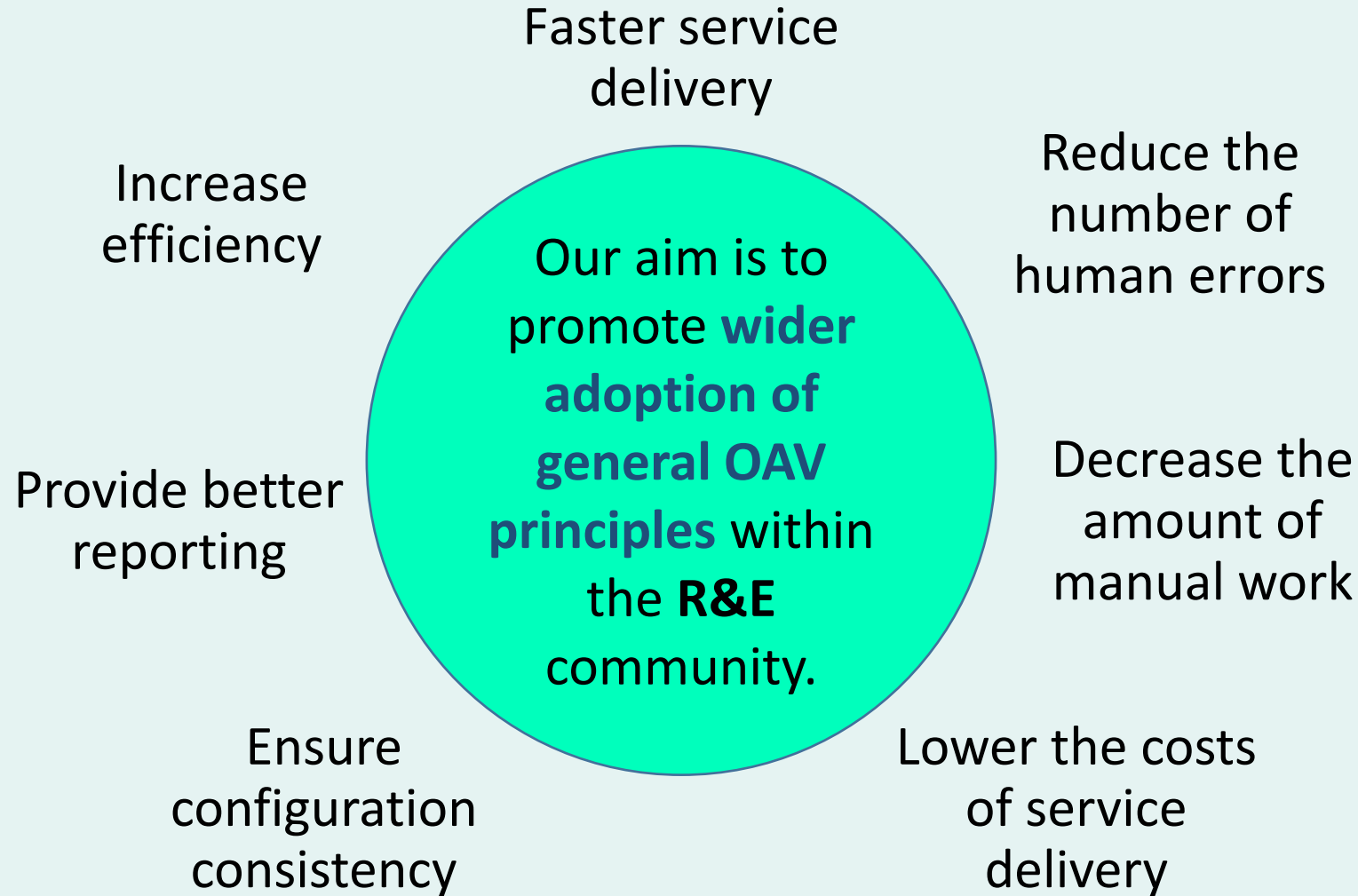


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Orchestration, Automation and Virtualisation (OAV)



Why Architecture, Training, Terminology, Maturity Model...?

- OAV Survey to the NRENs (published in Sep 19):

https://www.geant.org/Projects/GEANT_Project_GN4-3/GN43_deliverables/D6-2_Automation-and-Orchestration-of-Services-in-the-GEANT-Community.pdf

- Several discussions and workshops around the topic:
 - [GN4-3 Future Service Strategy Workshop, May 19](#)
 - [BoF session at TNC, June 19](#)
 - [STF17, July 2019](#)
 - [Network Management and Monitoring Workshop \(NEMMO\), Oct 19](#)

Collaborative approach to OAV in the GÉANT Community



Strong need for collaboration and exchange of knowledge and expertise



Knowledge as a gap



We speak different languages



A generally accepted architecture blueprint needed



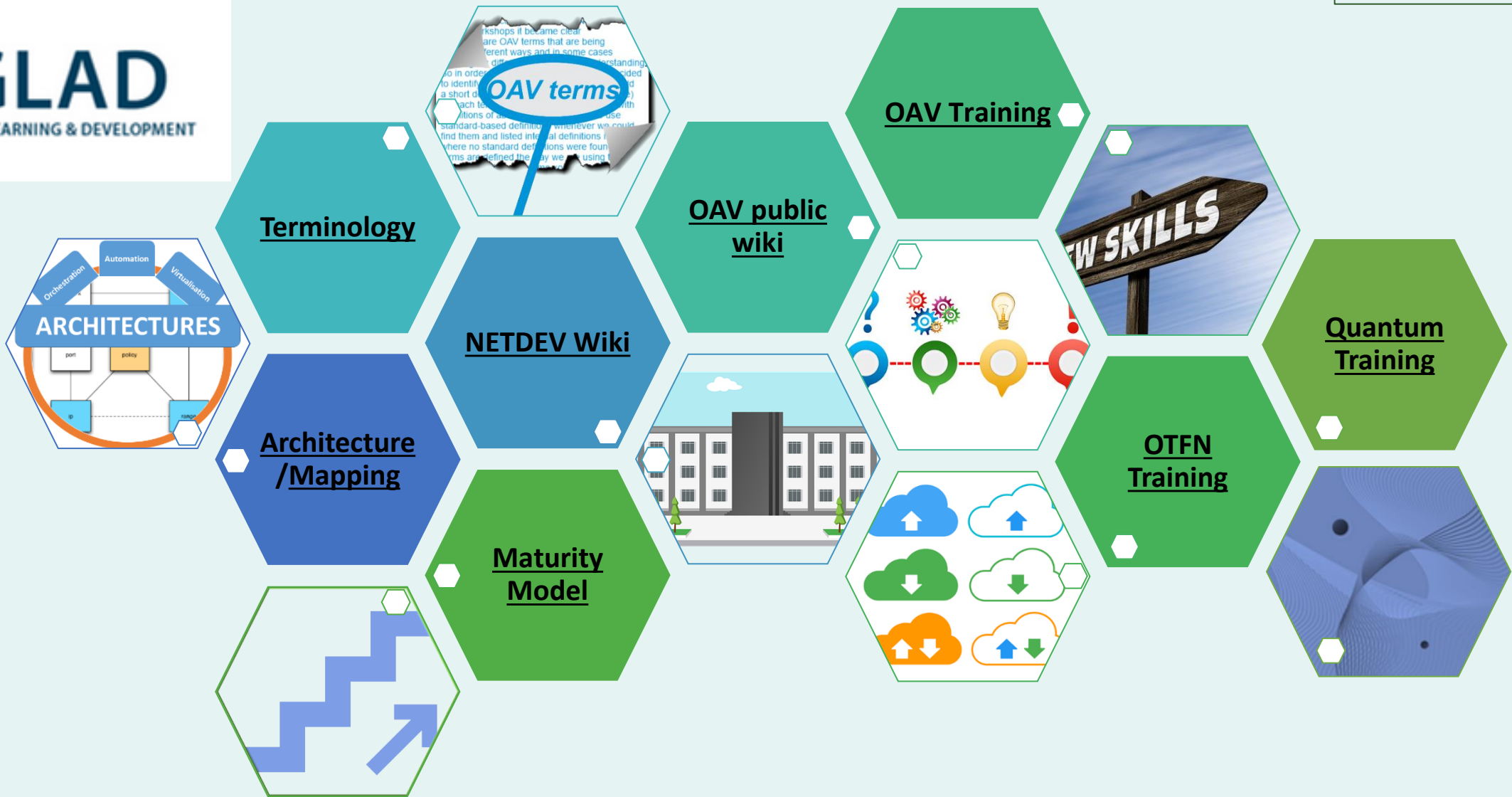
NRENs are willing to share experiences and learn from others

Network eAcademy Topics

Powered by:



Network
eAcademy

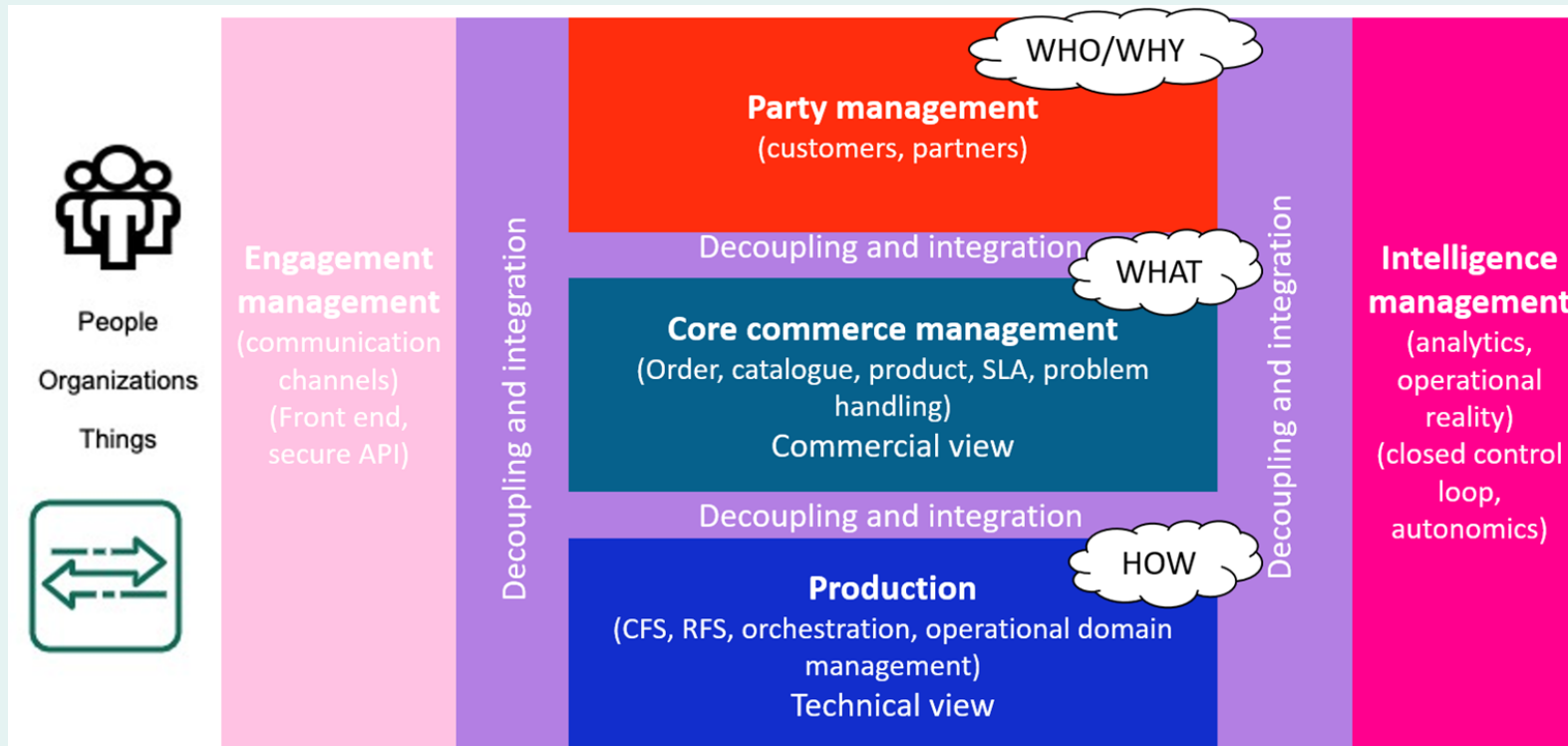


Architecture & Mappings

Architecture

e

Mapping NREN & use cases architectures to a common blueprint, the TM Forum Open Digital Architecture (functional architecture).



NREN mappings to date:

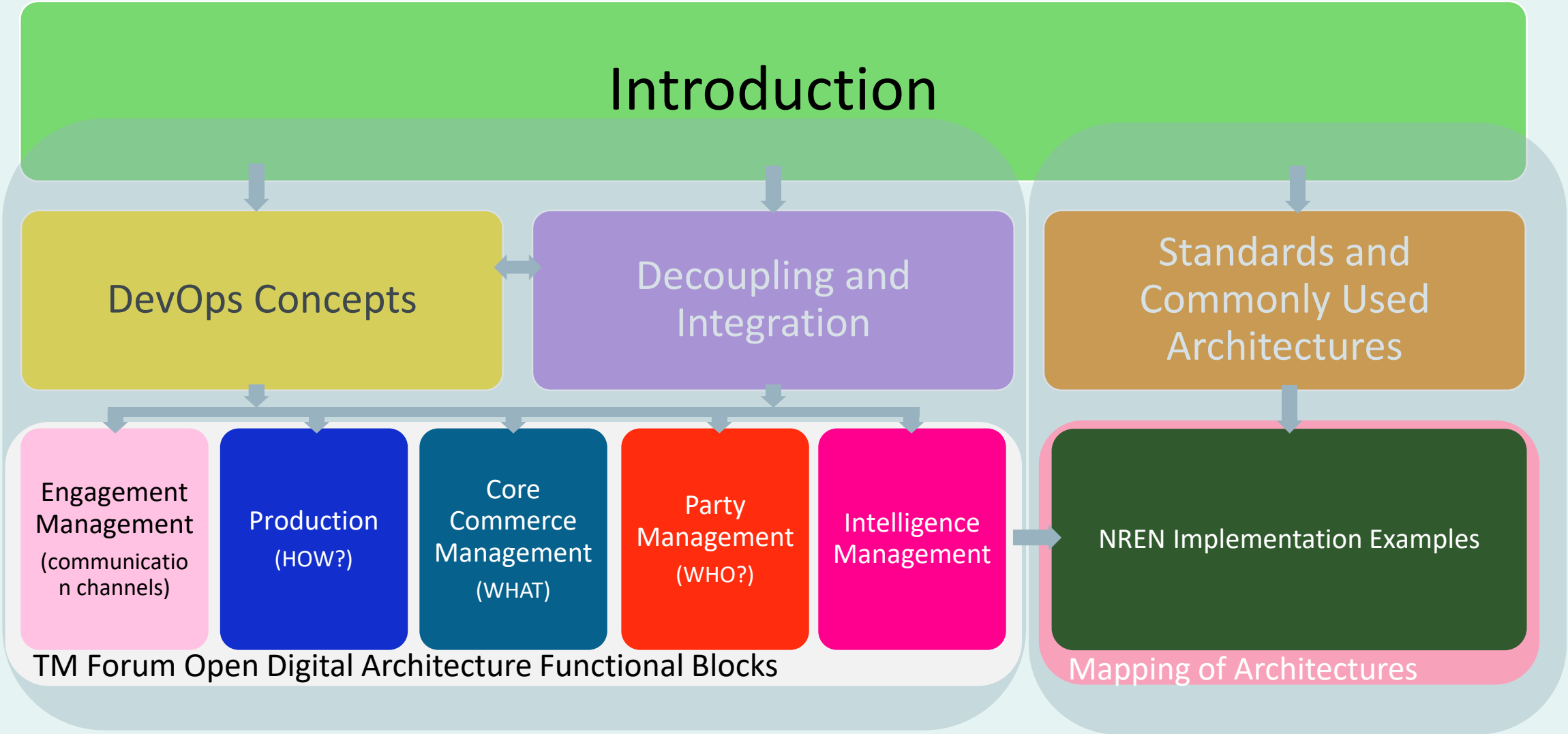
- [CARNET \(2\)](#)
- [CYNET \(2\)](#)
- [GÉANT](#)
- [GRNET](#)
- [HEAnet](#)
- [PIONIER](#)
- [SURFNET](#)

Platform mappings to date:

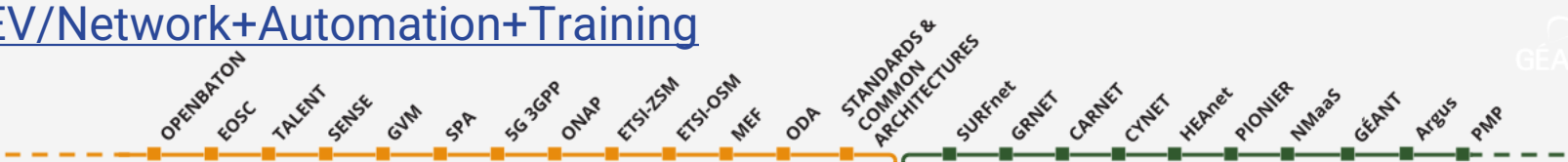
- [Argus](#)
- [NMaaS](#)
- [PMP](#)

Knowledge Map for the Training

Training



Network Automation eAcademy



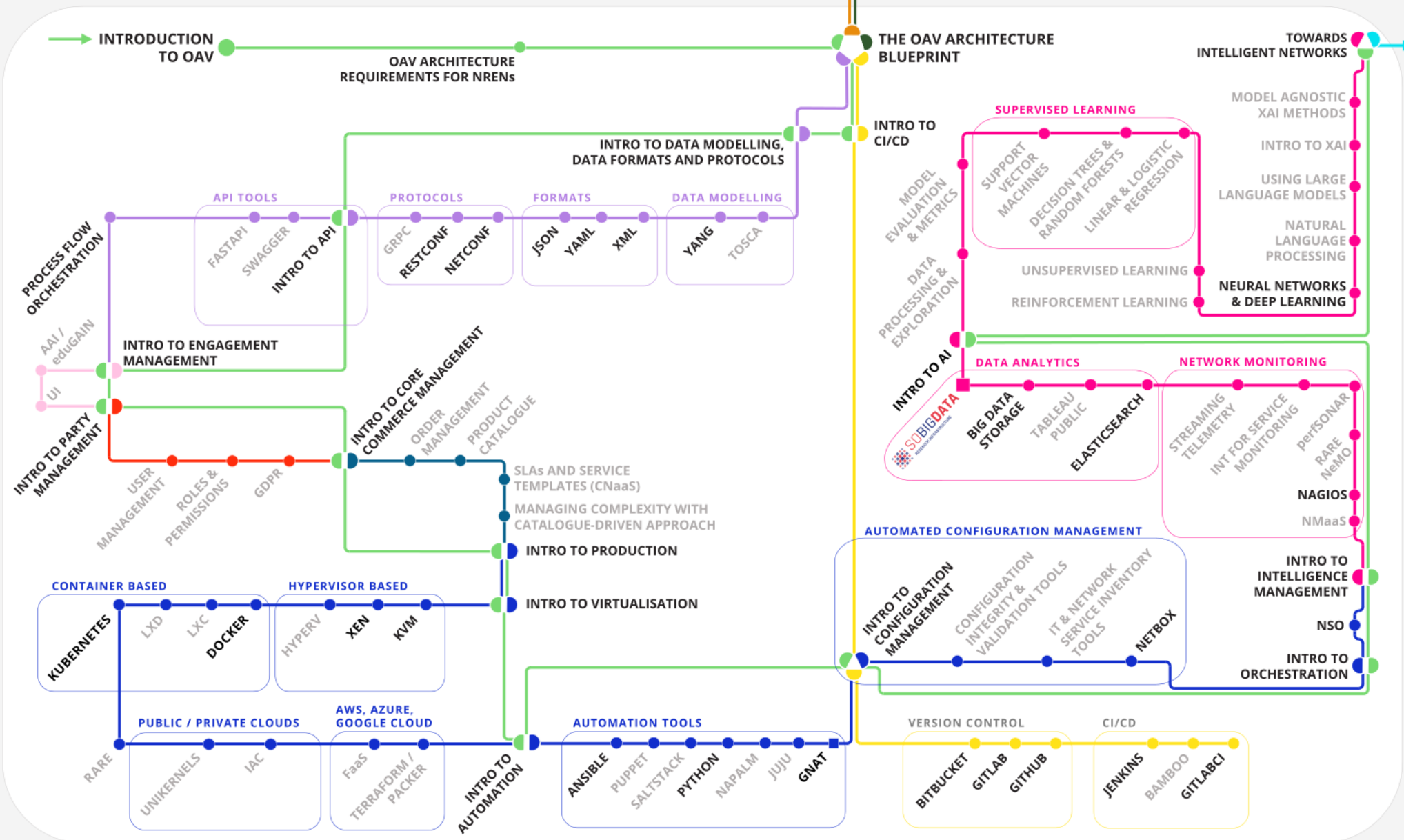
Legend

- Unit / Document / ext. link
- Released / Not released

Exchange point

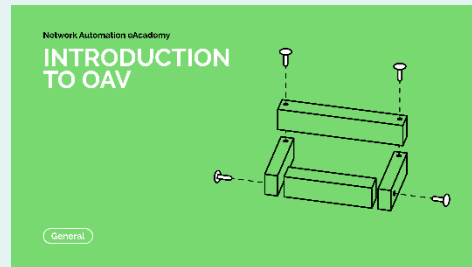
You can jump back and forth between this station and all exchange points at any time

Tracks

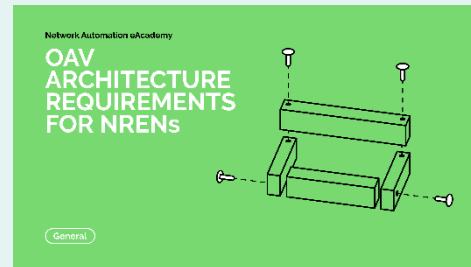


General Introduction Line

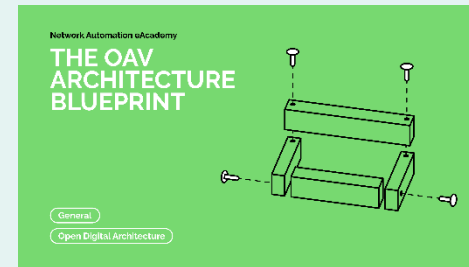
Training



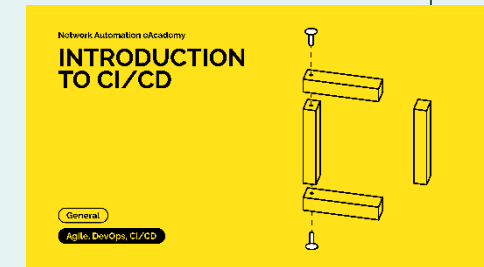
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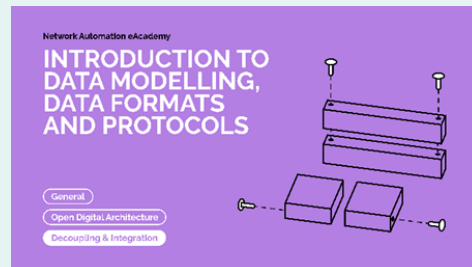
10'



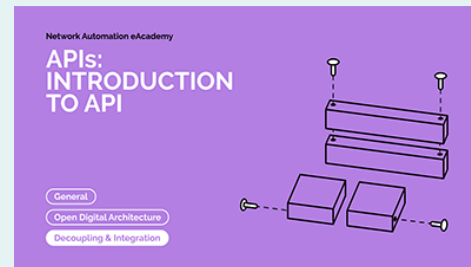
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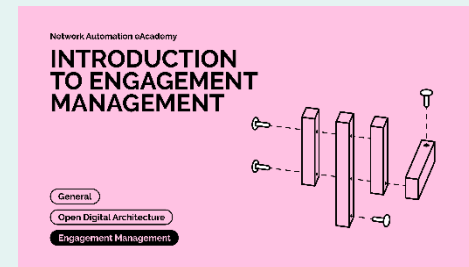
15'



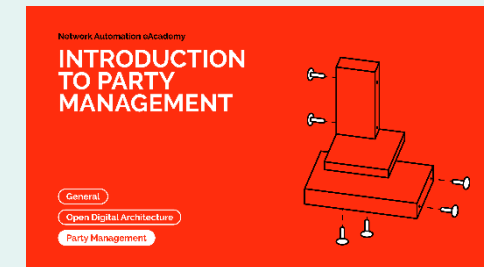
30'



45'



15'



15'



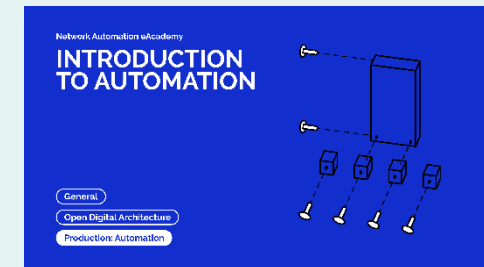
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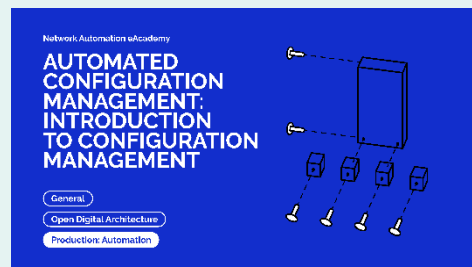
30'



30'



30'



30'



30'

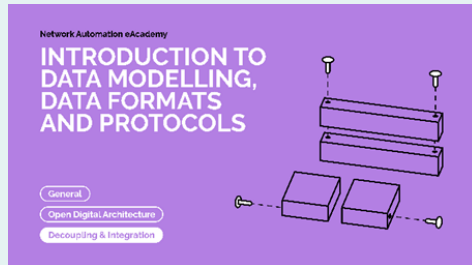


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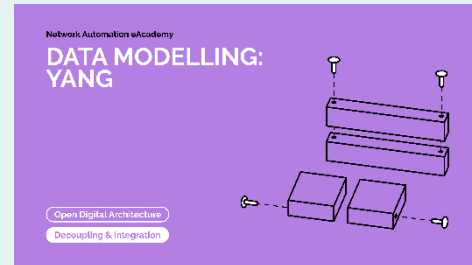
<https://wiki.geant.org/display/NETDEV/Network+Automation+Training>

Decoupling and Integration (Data Models, Formats, Protocols, APIs)

Training



30'



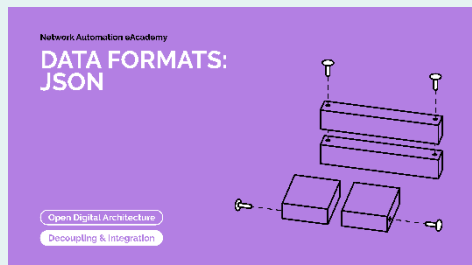
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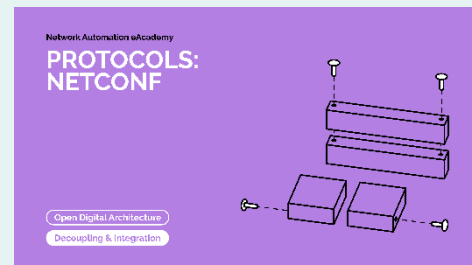
60'



30'



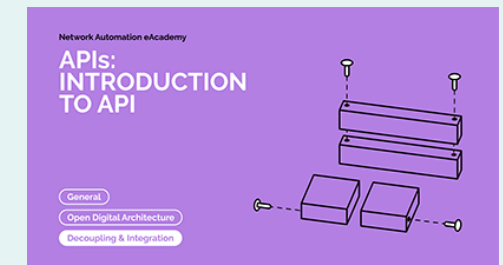
45'



4h (including installation)



2h



45'

<https://wiki.geant.org/display/NETDEV/Network+Automation+Training>

GÉANT eAcademy

Ansible

Home

My courses

Technical skills

Network

Network Automation eAcademy

Ansible

OVERVIEW

I - Settings, Inventory, Module Basics

II - Playbooks, Variables and Modules

III - How people use Ansible, Loops, Jinja2

IV - Playbook Validation, Vault, Roles, Sharing content

Test environments and Useful Links

Feedback and Completion Certificate

Welcome to the Course: Ansible

Network Automation eAcademy

AUTOMATION TOOLS: Ansible

Open Digital Architecture

Production Automation

COURSE DATE:

On Demand

DURATION:

60 minutes

COMMITMENT:

60 minutes + lab time

REQUIREMENT:

YAML Learning Module

COURSE TYPE:

Self-paced

CREDENTIAL:

Certificate

Learning path:	OAV Training Portal
Prerequisite:	Formats: YAML
Preceded by:	Introduction to Automation
Followed by:	Puppet (not yet published)
Next available:	Configuration Management

Course summary

Ansible is an automation framework which allows users to manage services, the servers on which they run and the network devices which interconnect them. This course has several sections which should be taken in order;



Ansible Requirement: YAML, YAML Requirement?

Training

 GÉANT eAcademy  

Formats: YAML

Home > My courses > Technical skills > Network > Network Automation eAcademy > Formats: YAML

OVERVIEW Main Goals Formats: YAML Useful Links Quiz Feedback & Certicate

Welcome to the Course: Formats: YAML



**COURSE DATE:**

From September 2021

**DURATION:**

20 min

**COMMITMENT:**

30 min

**REQUIREMENT:**

Introduction to Data Models, Data
Formats, and Protocols (recommended)

**COURSE TYPE:**

Selfpaced

**CREDENTIAL:**

Certificate of completion

Learning path:	OAV Training Portal
Preceded by:	Formats: XML
Followed by:	Formats: JSON

Course summary

YAML is a human-friendly data serialisation standard broadly used in Orchestration, Automation and Virtualisation (OAV). This course offers a quick overview of the YAML syntax and some examples from the real world in a single video, with useful tips and references and a quiz.

In more detail, the learning unit discusses the following topics:

<https://e-academy.geant.org/moodle/course/view.php?id=129>

Ansible→YAML→Data models, Data Formats, and Protocols

Training

 GÉANT eAcademy  

Data modelling, data formats and protocols - Introduction

Home > My courses > Technical skills > Network > Network Automation eAcademy > Introduction to data modelling, data formats and protocols

OVERVIEW Main Goals Course Materials Definitions Data Modelling Data Formats Protocols Links Quiz Feedback Form & Certificate of Completion

Welcome to the Introduction to Data Modelling, Data Formats and Protocols learning unit



Network Automation eAcademy
**INTRODUCTION TO
DATA MODELLING,
DATA FORMATS
AND PROTOCOLS**

General
Open Digital Architecture
Decoupling & Integration



COURSE DATE:

From January 2021



DURATION:

20 minutes



COMMITMENT:

30 minutes



REQUIREMENT:

None



COURSE TYPE:

Self-paced



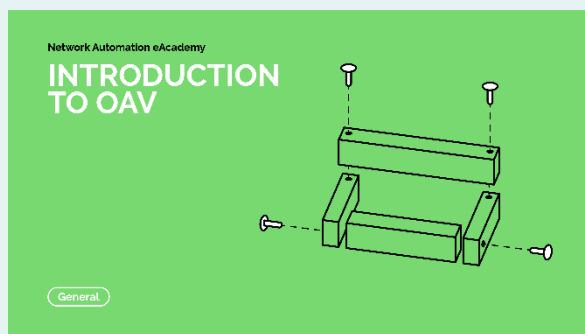
CREDENTIAL:

Certificate of Completion

Learning path:	OAV Training Portal
Preceded by:	Introduction to CI/CD
Followed by:	Introduction to APIs in the Introductory line Data Modelling: YANG in the Open Digital Architecture line

<https://e-academy.geant.org/moodle/course/view.php?id=61>

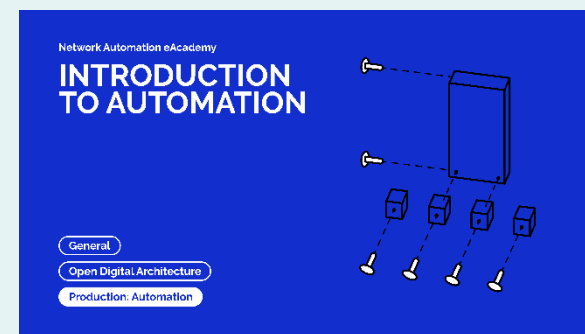
Ansible Paths



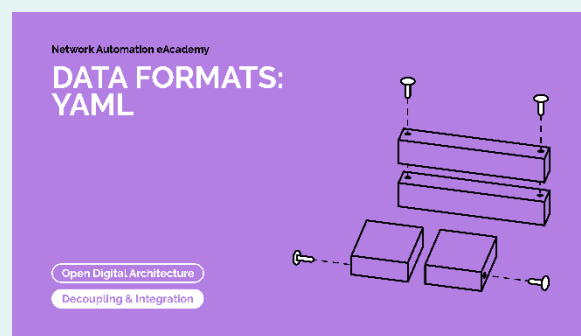
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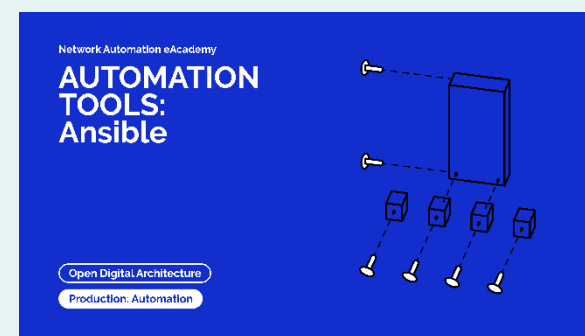
30'



30'



30'



60' + lab time

Ansible: Video with Subtitles

Training

GEANT eAcademy

Ansible

Home > My courses > Technical skills > Network > Network Automation eAcademy > Ansible > II - Playbooks, Variables and Modules

OVERVIEW I - Settings, Inventory, Module Basics II - Playbooks, Variables and Modules III - How people use Ansible, Loops, Jinja2 IV - Playbook Validation, Vault, Roles, Sharing content Test environments and Useful Links Feedback

Please watch the video below to continue your Ansible learning journey.

At the end of this section you will be able to

- Run playbooks and parse their outputs
- Use ssh troubleshooting to identify problems which Ansible may hide from you
- Understand Ansible's use of variables and how to reference their value
- Understand Ansible's `host_vars/group_vars` directory structure
- Understand what modules do and how to use them in playbooks

```
---
- name: Install mod_rewrite on all web servers
  hosts: web servers
  become: true
  tasks:
    - name: Install Apache
      apt: pkg=apache2 state=latest

    - name: enable mod_rewrite
      apache2_module: name=rewrite state=present
      notify:
        - restart_apache2

  handlers:
    - name: restart_apache2
      service: name=apache2 state=restarted
```

20 Section2/playbooks/install_Apache_with_handlers.yaml www.geant.org

Ansible section II - slides and speaker notes PDF document

Ansible: Slides with Speaker Notes

Training

GEANT eAcademy

Ansible

Home > My courses > Technical skills > Network > Ne

OVERVIEW I - Settings, Inventory, Module Basics II - Playbooks,...

Please watch the video below to continue your Ansible learning journey

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- Understand Ansible's use of variables and how to reference their
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- Understand what modules do and how to use them in playbooks

Ansible section II - slides and speaker notes PDF document

Playbooks

```
---
# Oh look, a comment...
# ...spread out over multiple lines

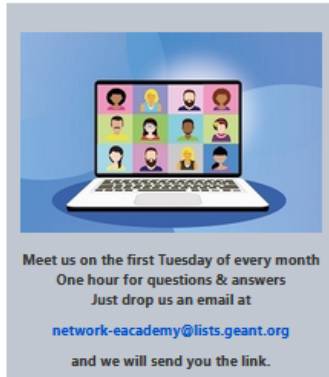
- name: Set up Apache           # Or nginx, or Mongoose
  hosts: webservers
  tasks:
    - name: install Apache
    - name: generate Apache config file
    - name: download Web content to relevant directory
    - name: restart Apache
    - name: eat cake
```

Most ansible users gather their Ansible work in YAML files called **Playbooks** – which start with three dashes. Playbook **comments** start with hashes, and are one per line. Playbooks contain a list of plays, or groups of tasks. In a playbook, look for the dashes in column one to see the list of plays. In the example shown here, there is one play (**Set up Apache**).

Playbooks can also contain the hosts or groups which the tasks should influence; these

Current Courses in the Network eAcademy – Automation

Training



Introduction

- OAV - Introduction (30')
- OAV Architecture Requirements for NRENS (10')
- The OAV Architecture Blueprint (30')

DevOps

- Introduction to CI/CD (15')
- **New:** Version control: Bitbucket (40')
- Version control: Gitlab (40')
- Version control: GitHub (2h)
- CI/CD: Jenkins (5h)
- CI/CD: GitlabCI (40')

TM Forum Open Digital Architecture

Decoupling & Integration

- Introduction to Data Modelling, Data Formats, and Protocols (30')
- Data Modelling: YANG (10')
- Formats: XML (60')
- Formats: YAML (30')
- Formats: JSON (45')
- Protocols: NETCONF (4 h - including installation)
- Introduction to API (45')
- Protocols: RESTCONF (2h)
- Process Flow Orchestration (45')

Engagement Management

- Introduction to Engagement Management (15')

Party Management

- Introduction to Party Management (15')

Core Commerce Management

- Introduction to Core Commerce Management (15')

Production

- Introduction to Production (30')
- Introduction to Virtualisation (30')
- Hypervisor-based Virtualisation: KVM (50')
- Hypervisor-based Virtualisation: XEN (90')
- Container-Based Virtualisation: Docker / Swarm (3h)
- Container-Based Virtualisation: Kubernetes (4h - including lab)
- Introduction to Automation (30')
- Automation Tools: Ansible (60' + lab time)
- Automation Tools: Python (90')
- Introduction to Configuration Management (20')
- **New:** Automated Configuration Management: NetBox (25')
- Introduction to Orchestration (30')
- Orchestration: NSO (6h - including lab)

Intelligence Management

- Introduction to Intelligence Management (15')
- Introduction to Automated Monitoring: Nagios (2h)
- Big Data Storage (1.5h)
- Elasticsearch (30')
- **New:** Introduction to AI (50')
- **New:** Neural Networks & Deep Learning (2h)

OAV Realisation

- Towards Intelligent Networks (30')

ADDITIONAL READING

Architecture Mappings

NREN use cases

- CARNET
- CYNET
- GÉANT
- GRNET
- HEAnet
- PIONIER
- SURFNET

other use cases

- Argus
- NMaaS
- PMP
- SPA

Architectures

- Standards & Common Architectures
- TM Forum ODA
- MEF
- ETSI-OSM
- ETSI-ZSM
- ONAP
- OpenBaton
- 5G 3GPP
- GVM
- SENSE
- TALENT
- EOSC

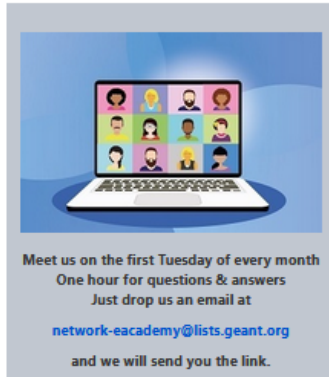
External Collaborations

- Automation tools: GNAT (GNOC)
- Database (SoBigData Academy)
- Data Analysis (SoBigData Academy)
- Legal and Ethical aspects of Data Science (SoBigData Academy)
- Information Retrieval (SoBigData Academy)
- Data Mining & Machine Learning (SoBigData Academy)
- Data Analysis with Spark (SoBigData Academy)
- Data Theory and Society (SoBigData Academy)
- Complex Network Analysis (SoBigData Academy)

<https://wiki.geant.org/display/NETDEV/Network+Automation+Training>

Current Courses in the Network eAcademy – Automation: CC BY-NC-SA License

Training



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(or social media)

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- Data Theory and Society (SoBigData Academy)
- Complex Network Analysis (SoBigData Academy)

<https://wiki.geant.org/display/NETDEV/Network+Automation+Training>

Terminology and Glossary of OAV Terms

Terminology

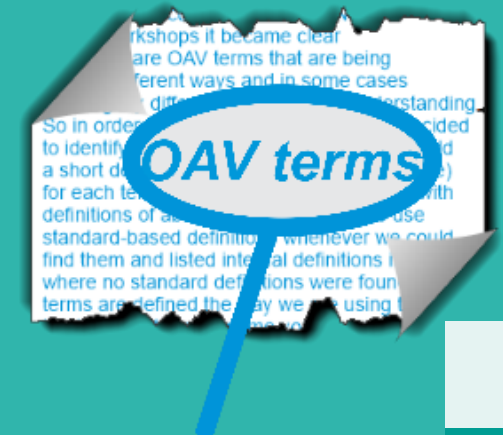
- Need for an agreement on common terminology.
- The idea is to have a common ground of understanding.
- Published version 3.0 with additional terms about AI and Maturity Model
- Accepted by the GNA-G Automation Working Group

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Glossary

OAV Terms	Definition and reference
AIOps	<i>AIOps is (the usage of) Artificial Intelligence for IT Operations. It combines big data and machine learning to automate IT operations processes, including event correlation, anomaly detection and causality determination.</i> • https://www.gartner.com/en/information-technology/glossary/aiops-artificial-intelligence-operations
AI-powered Virtual Agent (AIVA)	<i>An AI-powered Virtual Agent is an animated virtual character, more complex than a chatbot, that makes use of technologies like machine learning and natural language processing (NLP). This allows it to actively participate in a conversation, acting more like a human.</i> • Reference(s): based on https://www.ringcentral.com/virtual-agent.html and TM Forum AI Fundamentals course [TMF_AIF] and TM Forum "AI and its pivotal role in transforming operations" report and webinar [TMF_AI]
API (Application Programming Interface)	<i>An API is a set of commands, functions, protocols, and objects that programmers can use to create software or interact with an external system. Any data can be shared with an application program interface.</i>

<https://wiki.geant.org/display/NETDEV/OAV+Terminology>



OAV Maturity Model

Maturity Model

Measure	Measure the current OAV capabilities in a meaningful way
Identify	Enable clear identification of strengths and improvement points, be aware of threats and opportunities
Prioritise	Help prioritise what to do in order to advance and improve
Journey	Identify gaps between the current and future state and how to get there

OAV Maturity Model - Dimensions

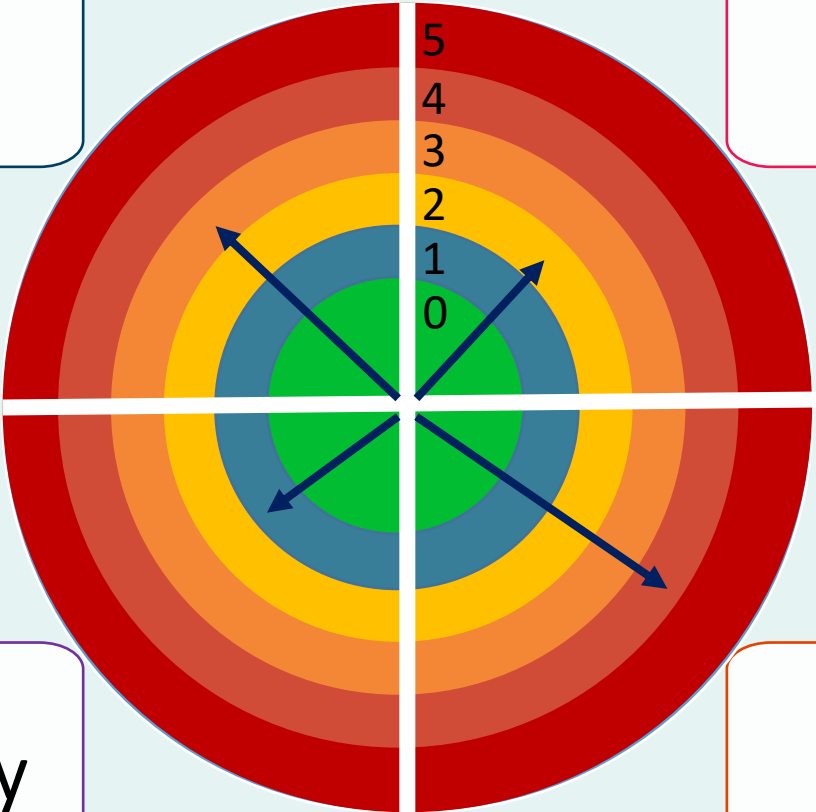
Maturity Model

Architecture &
Technology

Processes &
Services

Vision & Strategy

People &
Organisation



OAV Maturity Model - Stages

Maturity Model



The Maturity Model

Maturity Model

Survey (31 questions)*:

<https://www.surveymonkey.com/r/SPYDQVB>

Information to help you check your progress through stages and dimensions:

<https://wiki.geant.org/display/NETDEV/OAV+Maturity+Model>

Presentations of the OAV MM Infoshare:

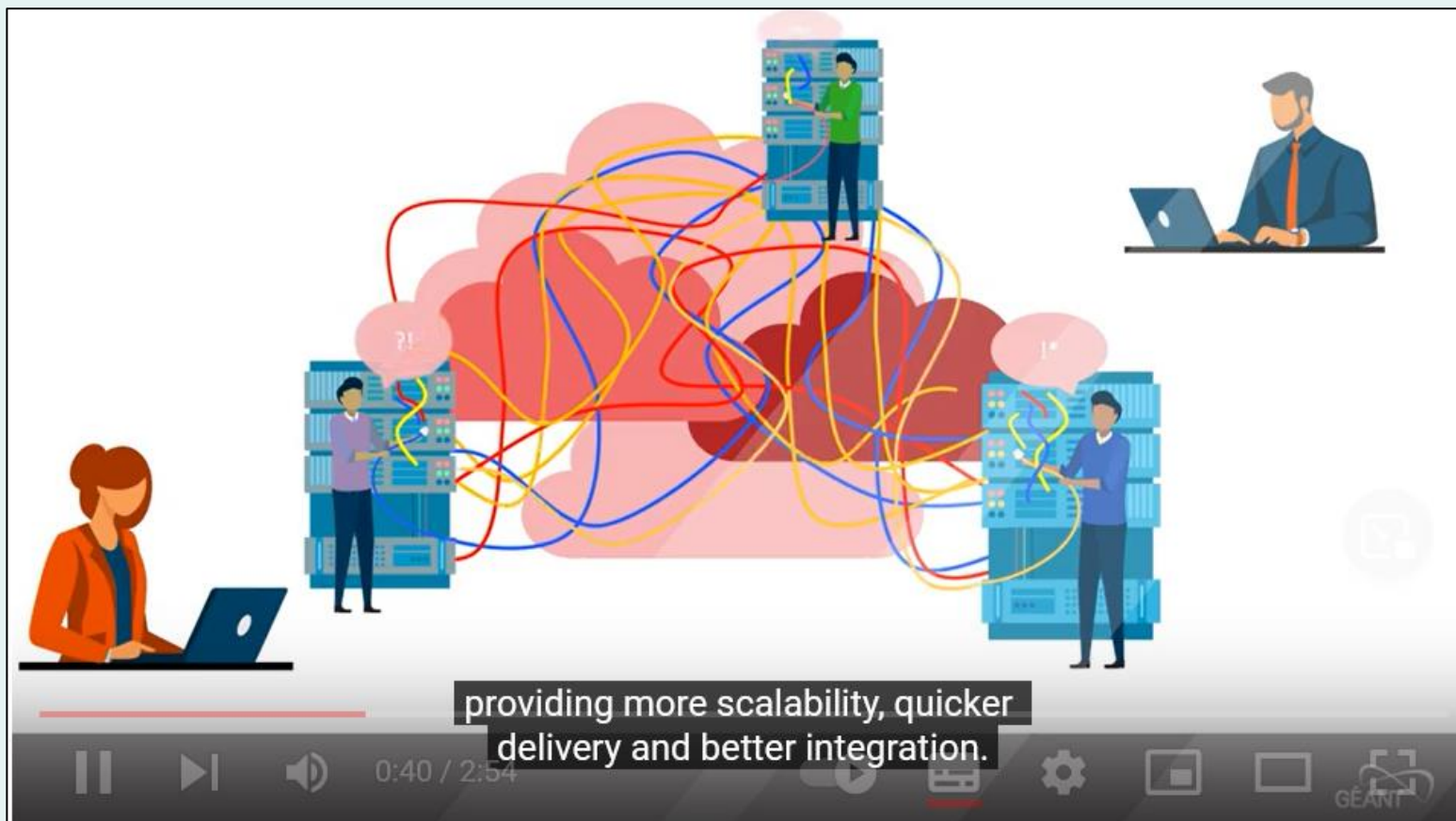
<https://events.geant.org/e/OAV-MM>

* Data is used for analytical purposes only (we don't publish data for individual institutions)

The report is sent to the person defined in the survey

Promoting Orchestration, Automation and Virtualisation (I)

Promotion



Towards Service Automation for Research and Education

Video in the GÉANT TV channel:

<https://youtu.be/Q5Wg1Qnqybg>

Promoting Orchestration, Automation and Virtualisation (II)

Promotion

Networks • Services • People



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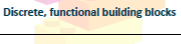
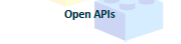
TOWARDS COLLABORATIVE DIGITAL SERVICES

The delivery of modern network services is evolving from services that were traditionally provisioned via heavily manual processes that were based on classic OSS/BSS platforms. Today's users demand self-service environments where they can make changes at a time that suits them. NRENs and their clients are reacting to this demand by embracing a digital transformation process - seeking to use digital platforms in an agile way - where that process mandates automation, modularity and flexibility. The drivers for automation are clear, including more efficient provisioning, and configuration consistency. It is also important to consider how a collaborative approach for the GEANT community can bring additional benefits.

As NRENs and R&E organisations embrace their digital transformation, it is important to foster such collaboration through the sharing of knowledge and experience within the GEANT community. Agreeing to implement Orchestration, Automation and Virtualisation (OAV) using a shared vocabulary and a common high-level architecture blueprint helps to ensure interoperability and, potentially, facilitate future inter-domain services as NRENs converge towards a shared objective for their users: the provision of true on-demand, self-service environments.

The search for such a blueprint led to the selection of the TM Forum's Open Digital Architecture (ODA), adopted by and driving the digital transformation of most communication providers. ODA is a reference framework which provides a common understanding and generality in an environment where each NREN is free to choose its own path towards OAV - including architecture, design and implementation.

Fostering collaboration and interoperability via common principles and guidelines

 Modular architecture approach	Loosely coupled components that work together in an orchestrated manner.
 Discrete, functional building blocks	Each component exposes well-defined functional capabilities.
 Open APIs	Each component is accessed via an Open API that fosters interoperability, supports multi-vendor environments, and is the basis for automation and orchestration.



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To learn more about GNA-3/GNA-3N visit www.geant.org/geantproject or use the QR code.



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Leveraging ODA to build interoperable (multi-domain) digital services

The ODA modular architecture supports efficient automation, data integrity and a streamlined approach to workflows with a template- and catalogue-based "single source of truth".

Within the GEANT community, the federated approach of supporting interoperable discrete functional building blocks translates to agreeing to a minimum set of common APIs - used both internally and externally - and a common description of composable abstract services and resources in the corresponding catalogues. In this way, the NRENs are able to implement the Vegas rule ("what happens in the domain stays in the domain"), meaning that each NREN remains in control of how it implements its platforms, and decides what and how much information (or level of abstraction) is exposed to other parties or systems via open APIs.

ODA Benefits

- Agile development of new services - Independent evolution of components - Multi-domain and federated services via standardised patterns - Technology agnostic blueprint - Integrates related standards - Faster support and troubleshooting	- Change management support - Zero-touch orchestration - Multi-vendor interoperability - Stepwise evolution - Model-driven service management - Support for autonomous networks - AI /ML ready
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OAV Wiki Knowledge Base

Terminology	https://wiki.geant.org/display/NETDEV/OAV+Terminology
Community Portal	https://wiki.geant.org/display/NETDEV/OAV+Community+Portal
White paper	https://wiki.geant.org/display/NETDEV/OAV+Architectures



- Want to align your architecture with ODA?
- Have an OAV use case you would like to share and work on with us?
- Looking for a particular component or an open API specification?
- Seeking/offering to provide OAV training?



Contact us at oav@lists.geant.org

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THE AUTOMATION, ORCHESTRATION AND VIRTUALISATION JOURNEY



**OAV WIKI**
<https://wiki.geant.org/display/NETDEV/OAV>

oav@lists.geant.org



The WP6 T2 team can help you on your OAV journey.

WHERE TO START?



Map your NREN architecture to the Open Digital Architecture* to start analysing the current situation

FROM A TRADITIONAL OSS/BSS

- Analyse components and functionalities
- De-couple & de-duplicate
- Expose components via APIs
- Automate manual tasks per component

VIA A DIGITAL PLATFORM

- Use orchestrators to implement complex processes spanning multiple components
- Agree on common terminology to understand each other
- Common service abstraction definition
- Interoperable interfacing via common Open APIs
- Federate with other NRENs or commercial providers

TO AN INTEROPERABLE COMMUNITY

- On-demand provisioning of multi-domain services using common APIs and data models

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Digital Platform Concepts and Principles*

* based on the TMForum Open Digital Architecture

Architecture building blocks

De-couple functionalities into separate components.
Use the single source of truth approach to data storage.
Implement DevOps to develop/maintain each component.

open APIs

Promote a multi-vendor environment where each component has a well-defined API.
Ensure interoperability with open API specifications.
Same APIs for intra- and inter-domain integration.

Orchestration and Automation

Start incrementally: automate repetitive daily tasks first.
Orchestrate multiple components using processes.
Innovate: don't improve existing manual processes or compromise - invent new, more efficient workflows.

Service abstraction

Define abstracted service representations.
Describe services and resources using catalogues.
Re-use components for all services.



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Towards Collaborative Digital Services Pamphlet and Infographic:

https://www.geant.org/Resources/Documents/OAV_Arch_text_and_infographics_new_links.pdf

- [Community Portal](#)
- Sections for OAV:
 - [Architecture](#)
 - [Training](#)
 - [Maturity Model](#)
 - [Terminology](#)
 - [Literature](#)
 - Examples of usage: [CNaaS](#), [DTN](#)
 - [Dissemination](#): Deliverables, Infoshares, P

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z		
	OAV Examples by Country	
AARNET, Australia		• https://www.aarnet.edu.au/ • Hindrik Buining, David Jericho, Orchestration, Automation and Virtualisation, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf)
ARNES		• https://www.arnes.si/ • ARNES is working on the project WLAN-2020 to offer wireless connection within the schools in the country, hiring consultants during the deployment phase. They are using Automator as the middleware and doing ZTP (Zero Touch Provisioning). • They have built the ARNES network service orchestration stack, automation based on Ansible. • https://geant.app.box.com/s/68pzzsqbkc9683j8qybgol5tu7jhtz
CARNET		• https://www.carnet.hr/ • Damir Regvart, Lidija Jakovčić, Silvije Milišić, CARNET OAV, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf) • CARNET is also working on a national project to offer wireless connection within the schools in the country (https://www.e-skole.hr/en/results/adequate-ict-infrastructure-in-pilot-schools/), with a network management system built by them (Management system for the educational system). CARNET does the network provisioning and monitoring through an API: https://geant.app.box.com/s/fj5tdbv2dhxfed137ki7mj806mml16 • See the lightning talk during the Network Management and Monitoring Workshop.
CSUC		• https://www.csuc.cat • CSUC has automated the provisioning of new circuits in the L2 and L3 devices using Rundeck, Python scripts and Ansible modules for Anella Cientifica (Regional Research and Education Network in Catalonia). • For the Internet Exchange, CATNIX, CSUC has an internal portal where customers can add their new MAC addresses and the filters are uploaded in the switches through Python scripts.
CyNet		• http://www.cynet.ac.cy/ • whitepaper: CYNET OAV Architecture Analysis, https://www.geant.org/Resources/Documents/GN4-3_White-Paper_CYNET_OAV_Architecture_Analysis.pdf • Iacovos Ioannou, Active member of OAV working group of WP6-T2.
ESnet, USA		• http://es.net/ • John MacAuley, Service orchestration in ESnet6, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf)
FUNET		• https://www.csc.fi/funet-kaikki-palvelut • Asko Hakala, Workshop on Network Management and Monitoring, Copenhagen, October 2019: https://wiki.geant.org/download/attachments/131629403/Funet%20Kampus%20Service.pdf?version=1&modificationDate=1571047057236&api=v2. • Kampus Service Project. All new customer provisioning is automated, with no manual configuration (only physical installation). • Everything automated using Ansible, configuration stored in YAML files.
GÉANT		• https://www.geant.org/ • Bram Peeters, Orchestration, Automation and Virtualisation (OAV) in GÉANT, GN4-3 Future Service Strategy Workshop, Amsterdam, May 9, 2019 (pdf) • Mian Usman, Orchestration and Automation, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf) • Tony Barber, 10th SIG-NOC meeting presentation

Timemap



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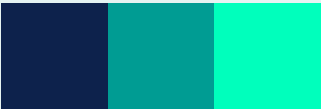
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the European Union

Road report: on HWY 101 there are 364 vehicles per minute



it may
Be nice

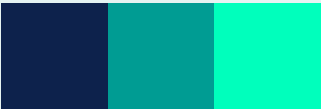
...



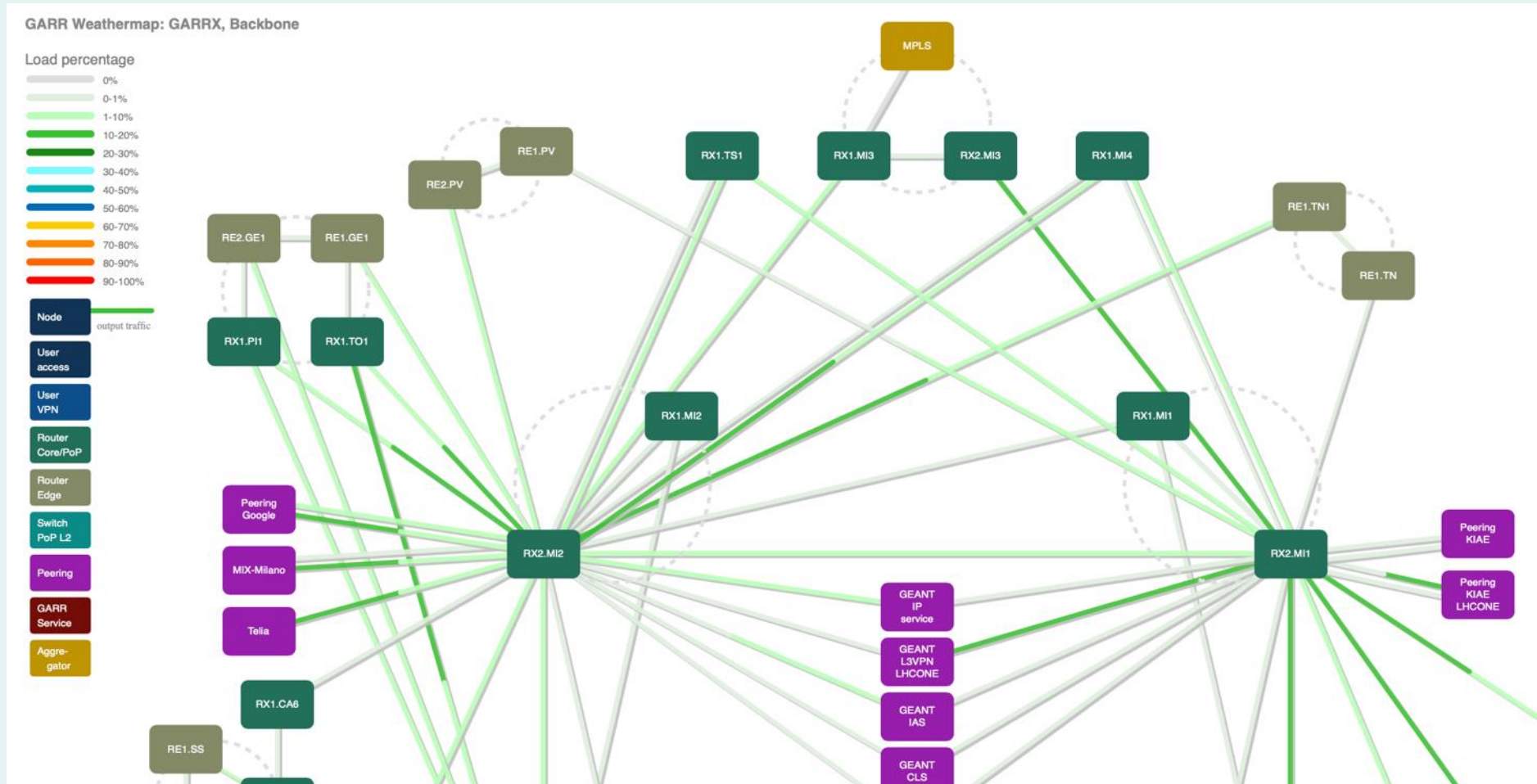
Road report: on HWY 101 there are 364 vehicles per minute!



Or...
Lots of
Stop &
Go



Current weather maps are useful for bulk data transfer!



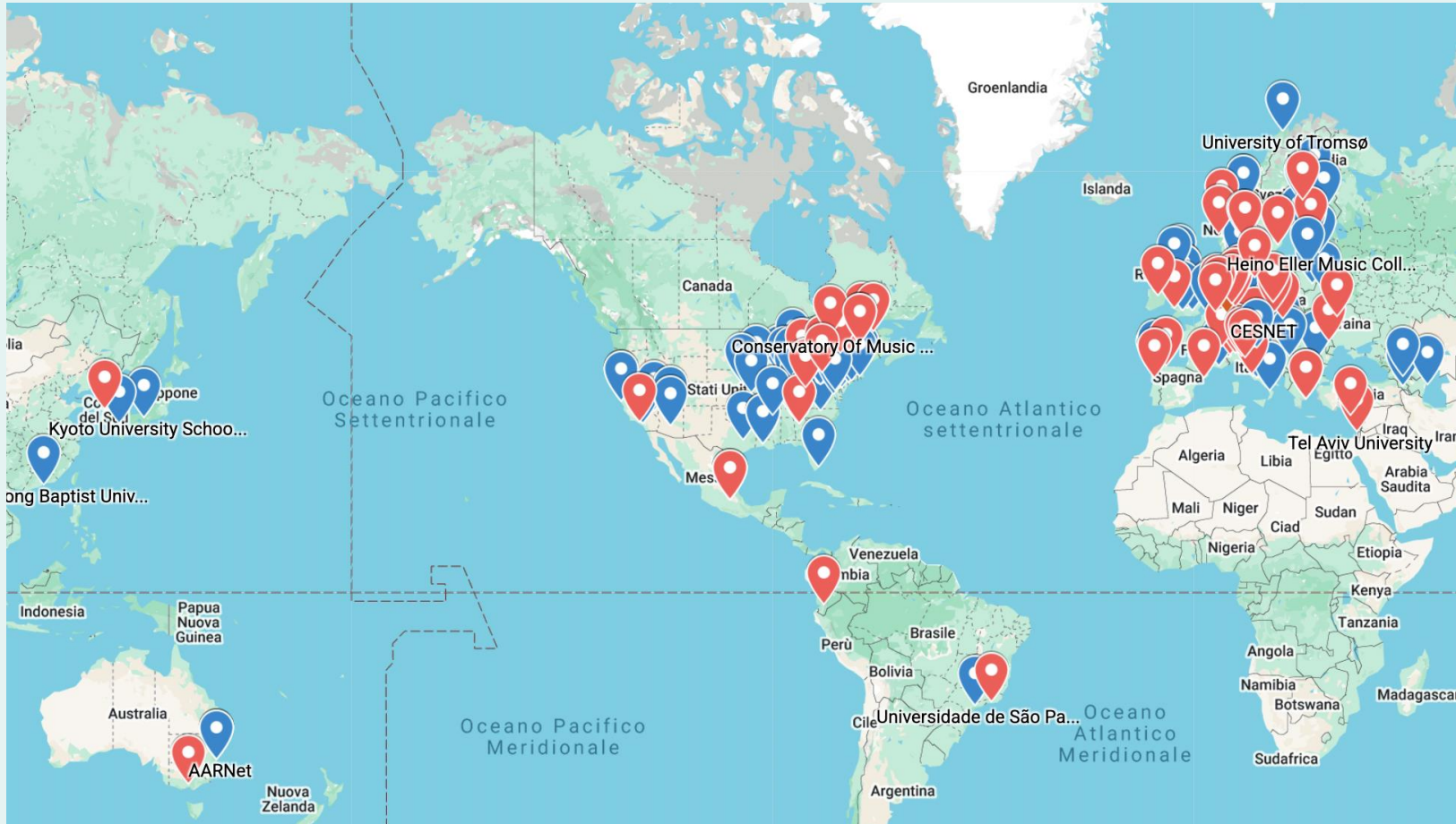
Applications which need “cruise control” on are on fast rise!

- **LoLa**

And we have others:

**Ultragrid
MVTP**

...



What do we need to check?



Bandwidth:
3 x 450Mbps

Latency (RTT):

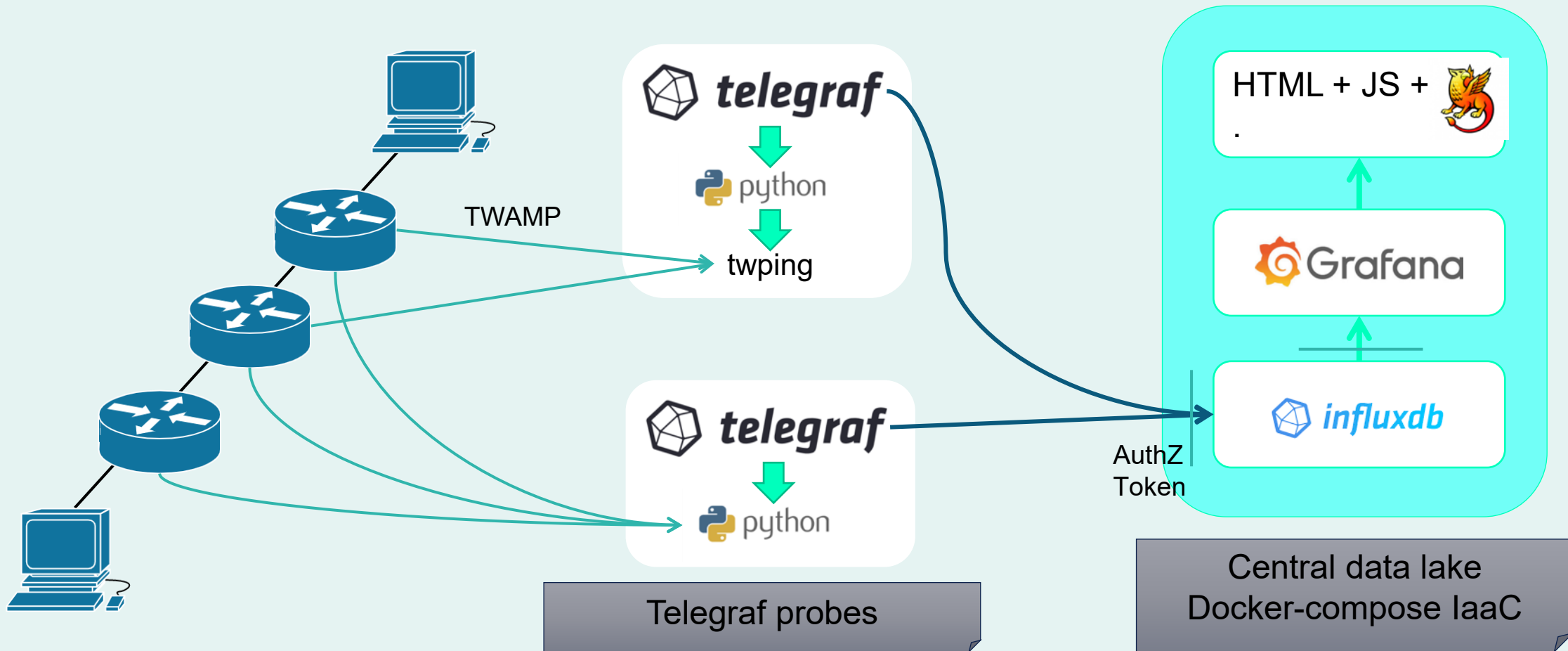
- 15ms
- 25ms
- 37ms

Jitter:

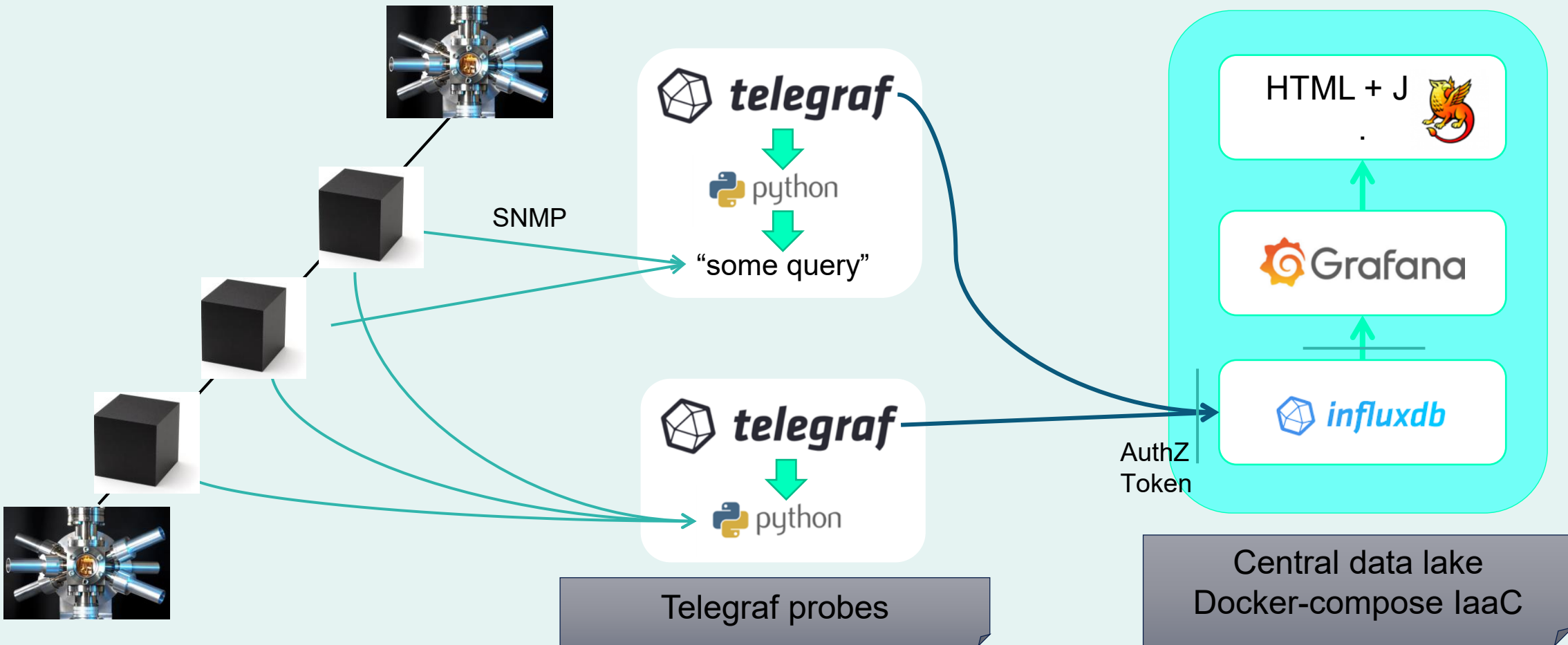
- 1.01ms
- 0.97ms
- 1.10ms

But also clocks time drift, and other parameters...

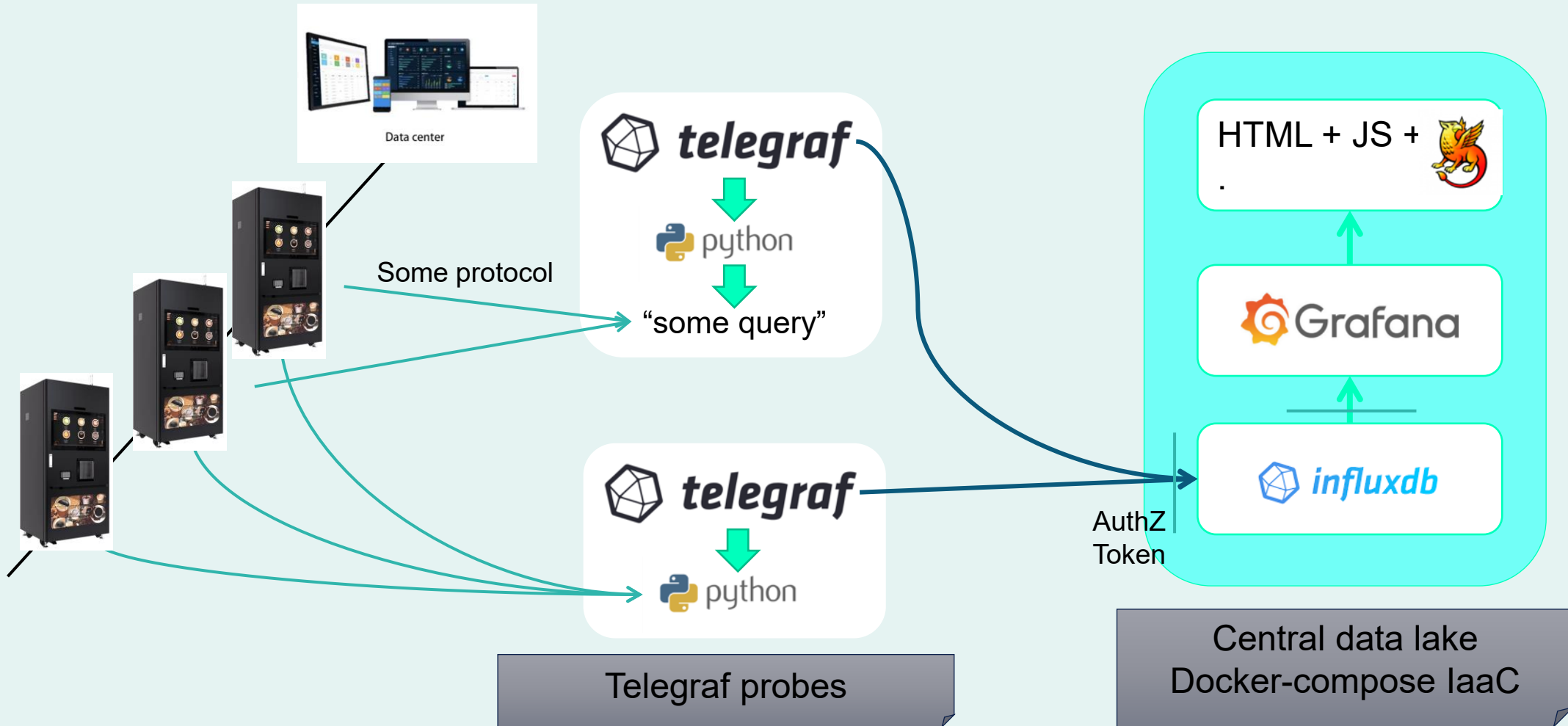
TIMEMAP architecture – the universal core



TIMEMAP architecture – the universal core OTFN



It can monitor whichever device providing data



Timemap (latency-jitter) main features

- Latency & Jitter data collection
- Simplicity: almost zero footprint
 - Docker + standard Linux packages, minimal custom code
- Security and flexibility
 - eduGAIN federated authentication
 - multi-tenancy in Grafana and InfluxDB
 - R/W authorization token for APIs



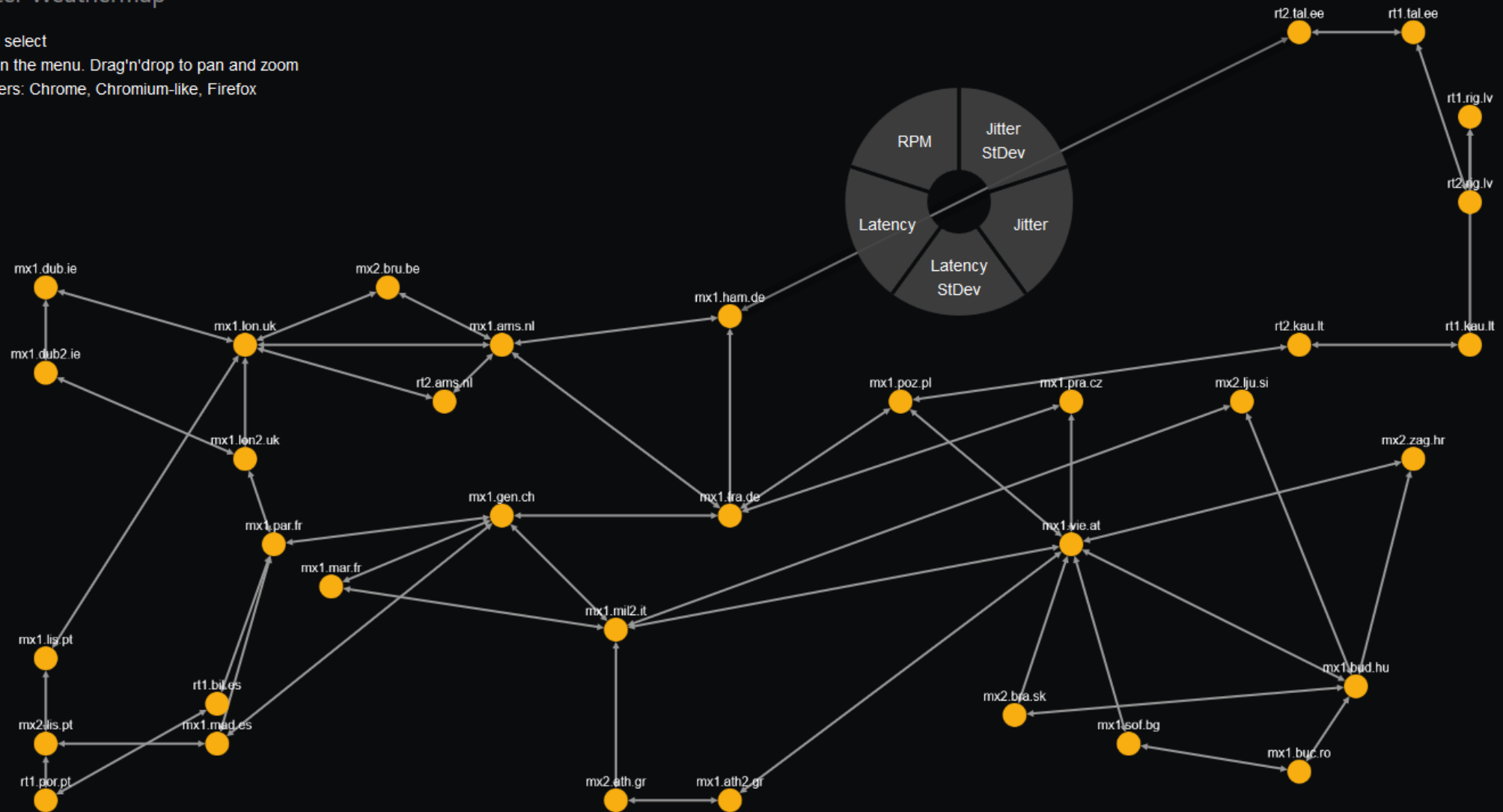
Timemap useful examples

Latency-Jitter Weathermap

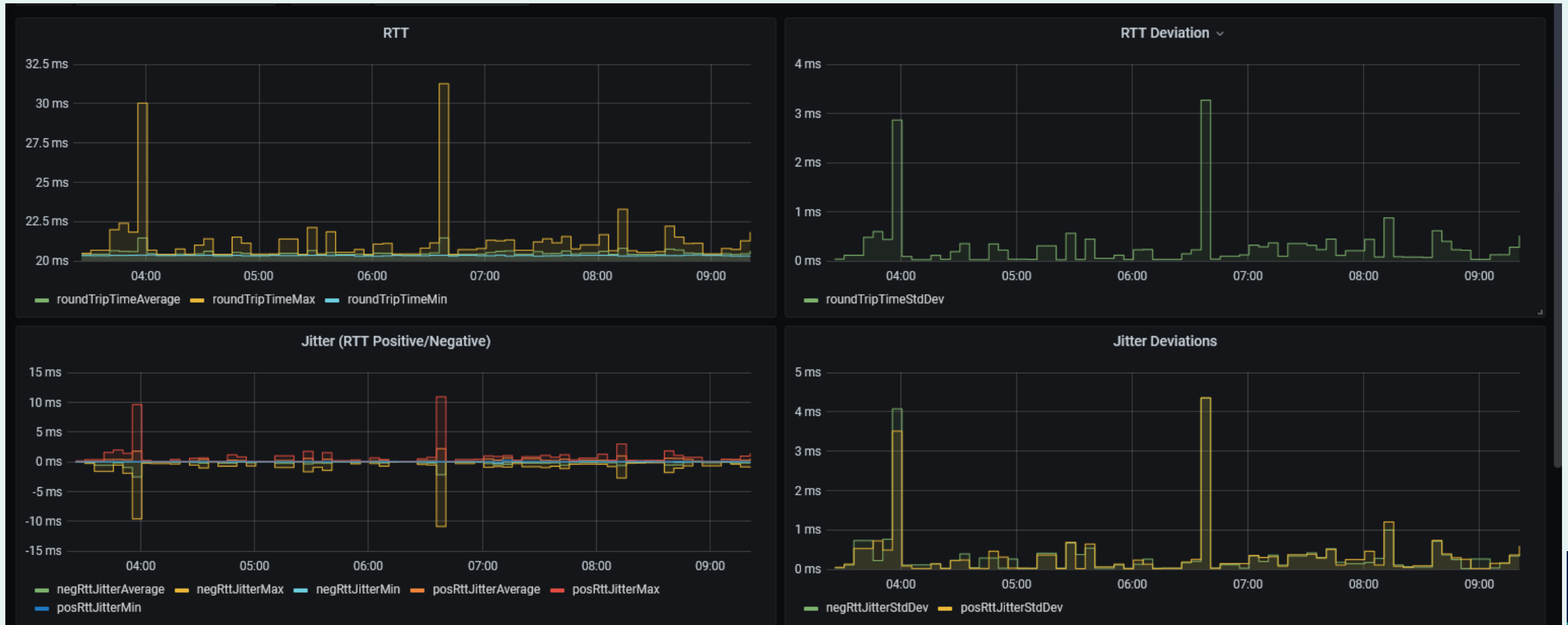
Click on a link to select

Hold click to open the menu. Drag'n'drop to pan and zoom

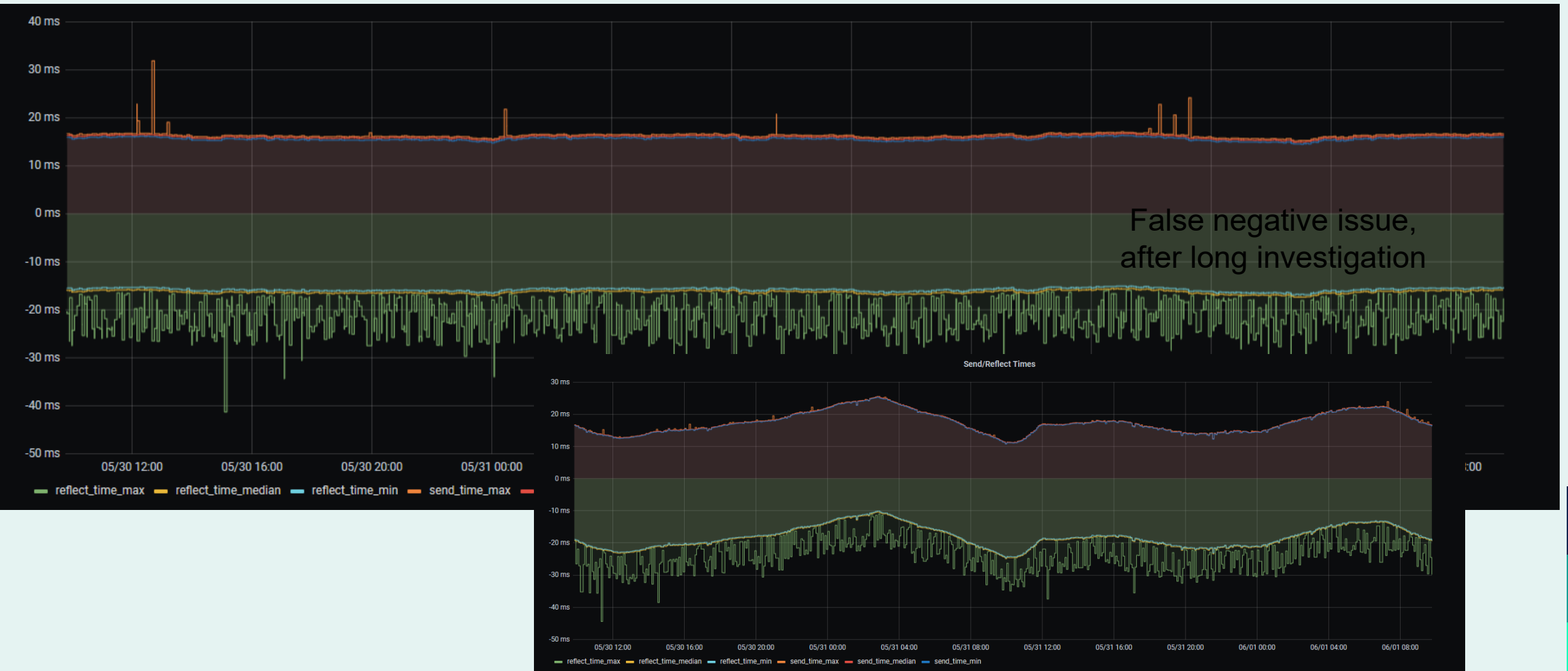
Preferred browsers: Chrome, Chromium-like, Firefox



Timemap useful examples: rerouting and periodic events



Timemap useful examples: trends



Thank you

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