



# Network eAcademy

Maria Isabel Gandia Carriedo, CSUC/RedIRIS

INEX Member Meeting  
7th September 2023, Dublin, Ireland

Public (PU)

## Maria Isabel in a Nutshell



# CATNIX

Catalonia Neutral  
Internet Exchange

## Maria Isabel in a *three* Nutshells



# CATNIX

Catalonia Neutral  
Internet Exchange

# ANELLA CIENTÍFICA

## Maria Isabel in *a three* Nutshells



# CATNIX

Catalonia Neutral  
Internet Exchange

# ANELLA CIENTÍFICA

# GÉANT

Networks • Services • People

# The GÉANT Project



**GÉANT's vision** is to ensure equal network access for all scientists across Europe to the research infrastructures and the e-infrastructure resources



The GÉANT Project is a part of the European Union's Horizon Europe research and innovation programme under the seven-year Framework Partnership Agreement (FPA)



500 contributors from 37 partners - European R&E Institutions

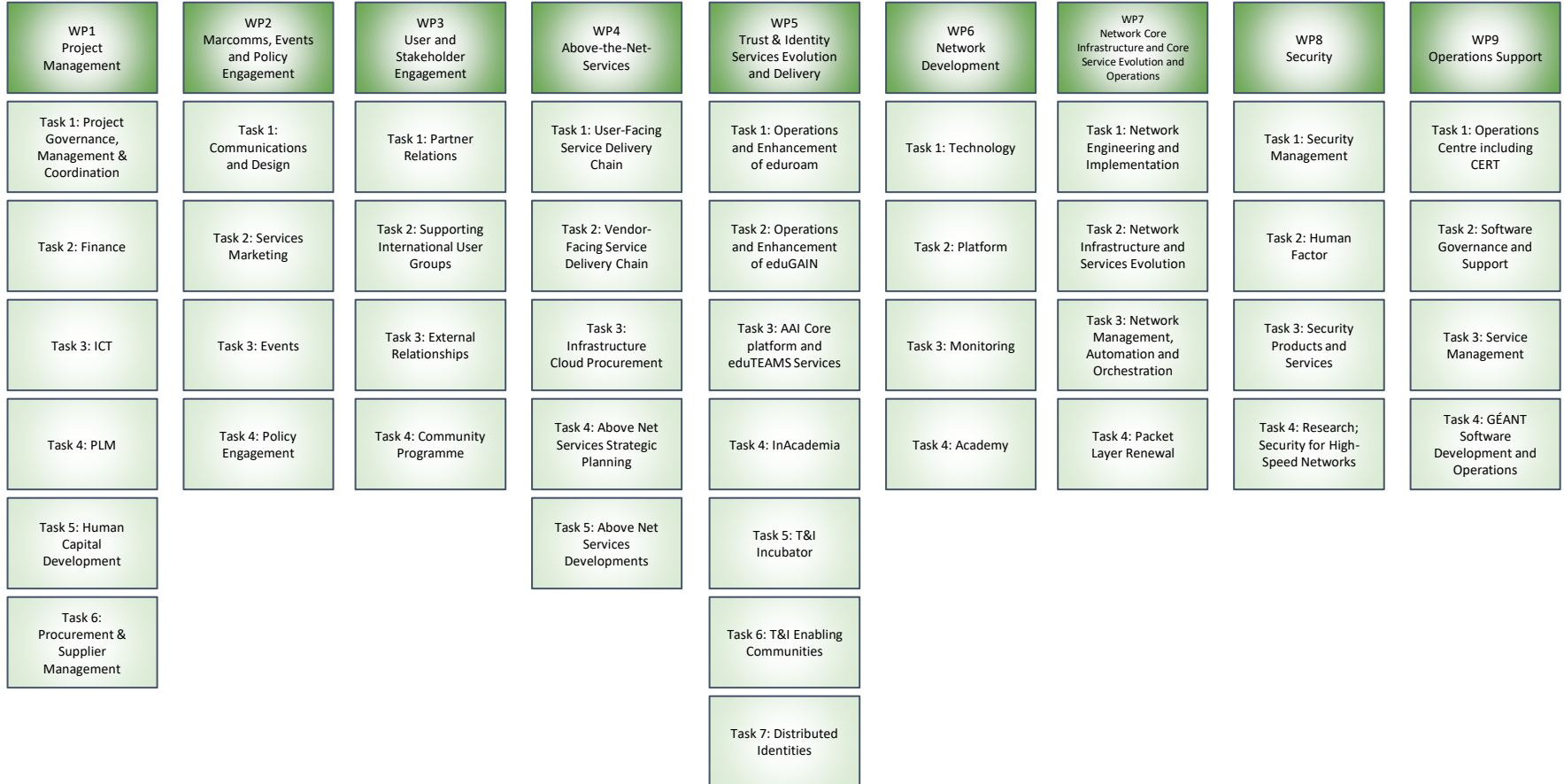


50 M users

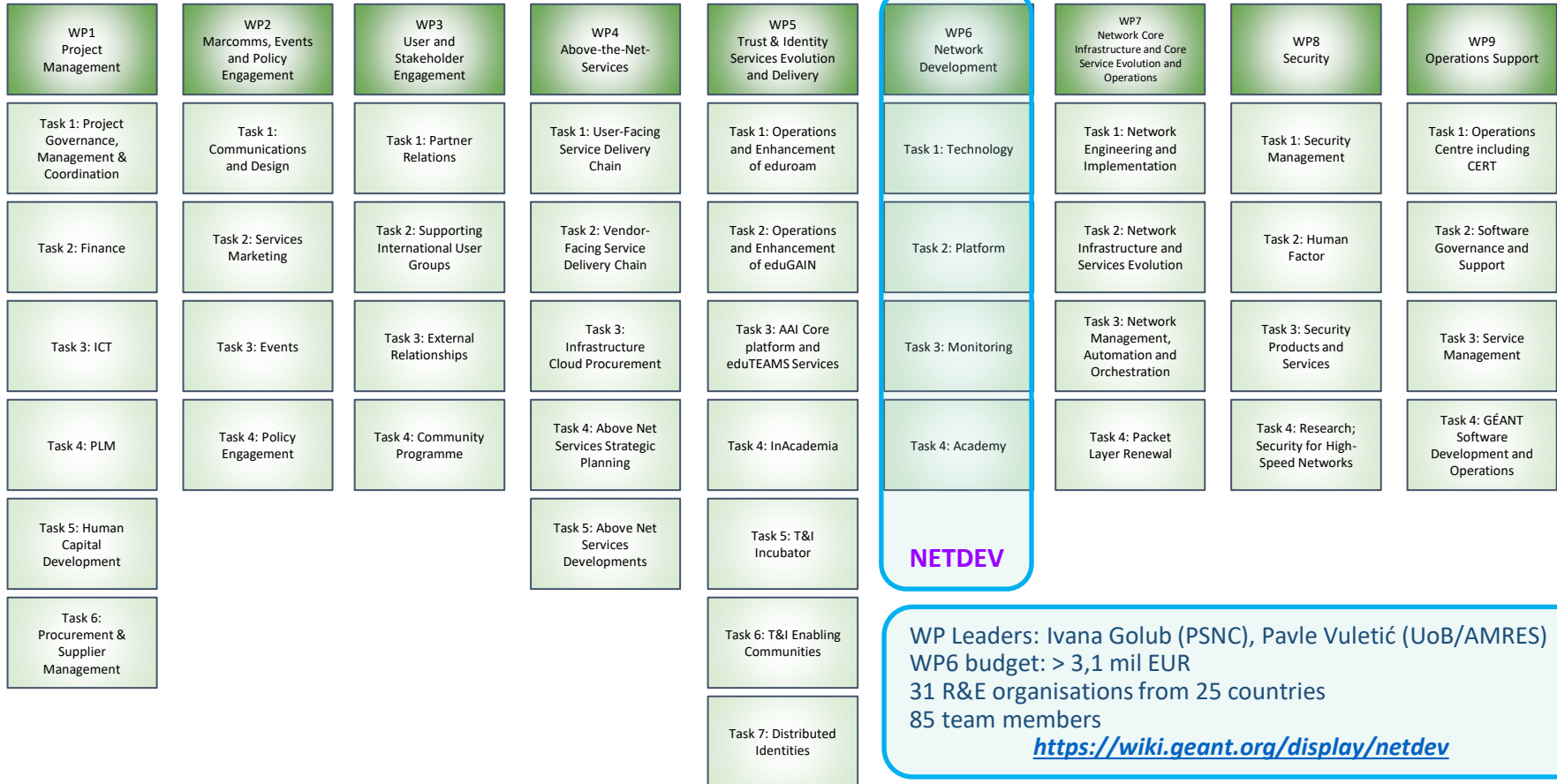


GÉANT 5-1 (GN5-1) Project duration: 1 Jan 2023 – 31 December 2024

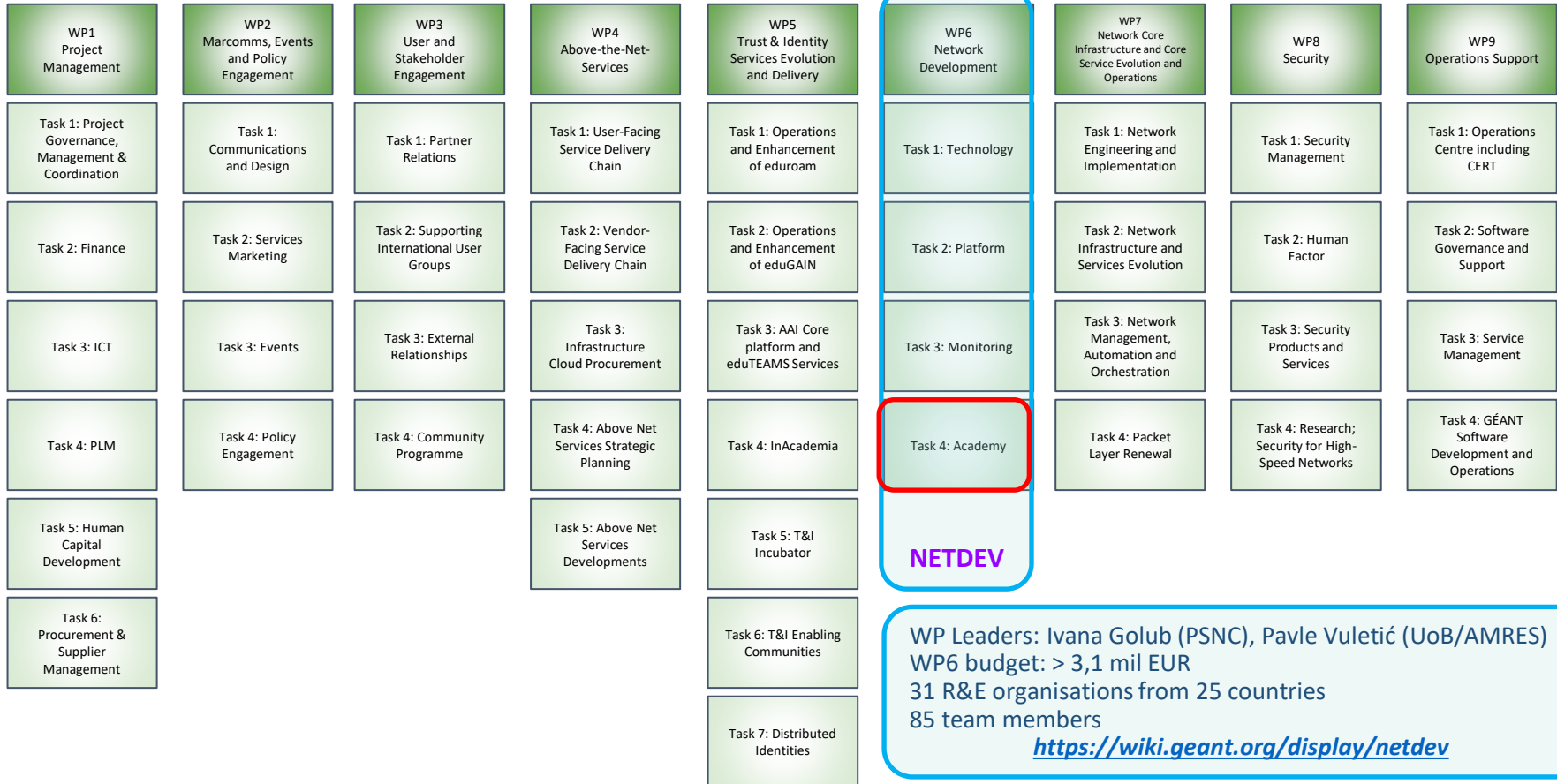
# The GÉANT 5-1 Project Structure



# The GÉANT 5-1 Project Structure



# The GÉANT 5-1 Project Structure

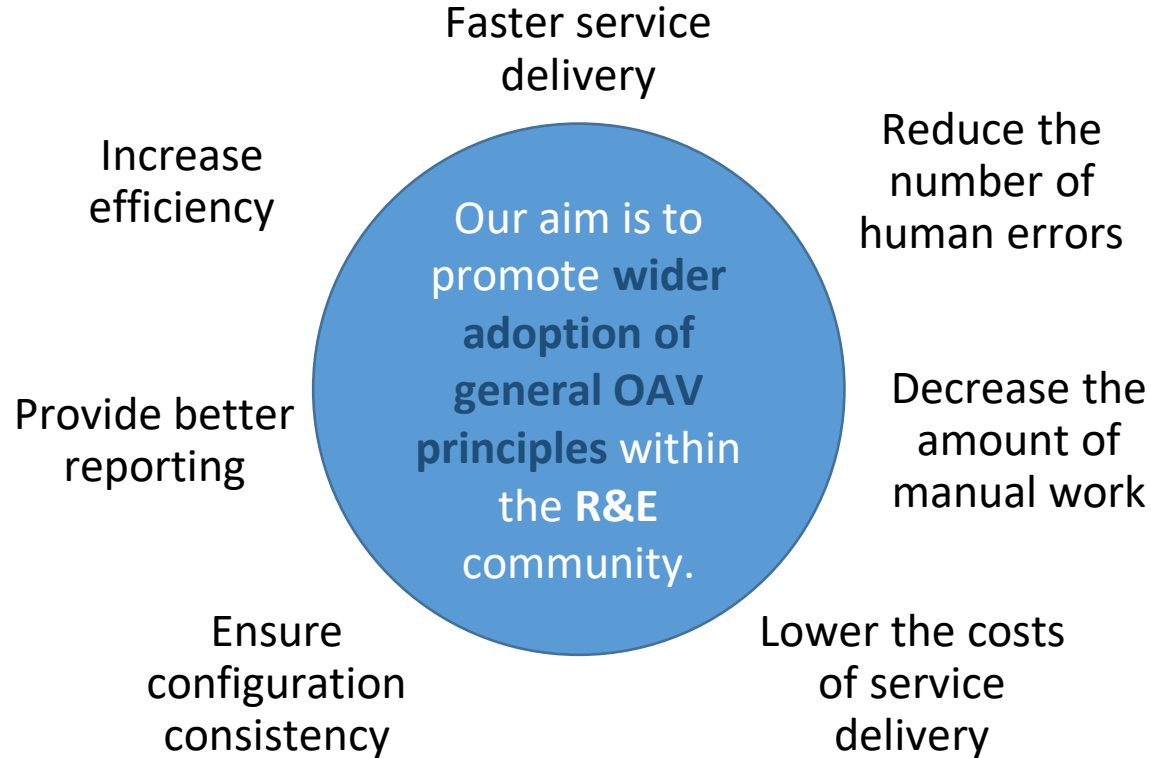




## Agenda: Network eAcademy

- Introduction: Orchestration, Automation and Virtualisation
- Architecture/Mapping
- Training
- Terminology
- Maturity Model
- Promoting Orchestration, Automation and Virtualisation

## OAV: Orchestration, Automation and Virtualisation



## 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](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



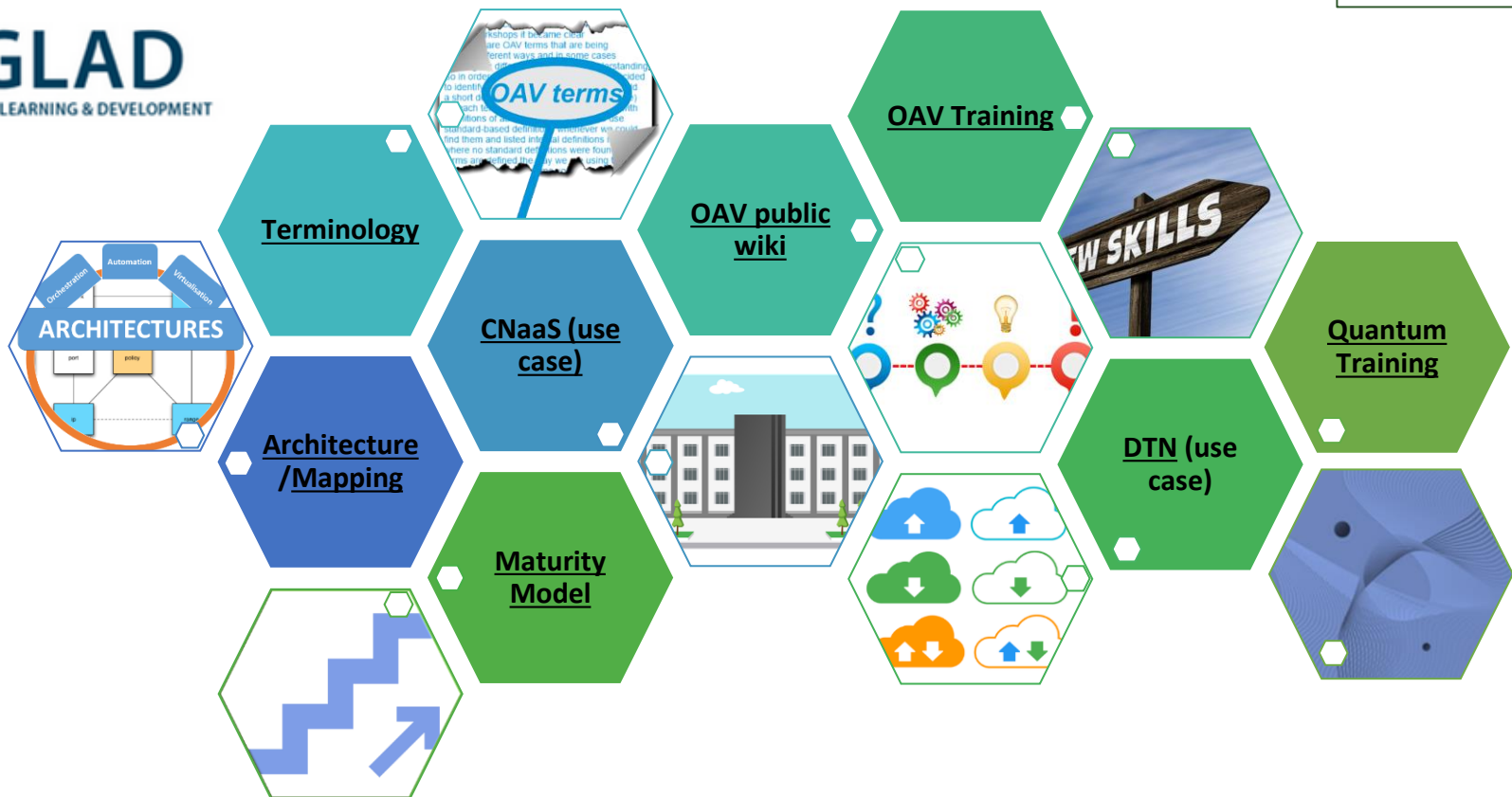
NRENs are willing to share experiences and learn from others

# Network eAcademy

Powered by:

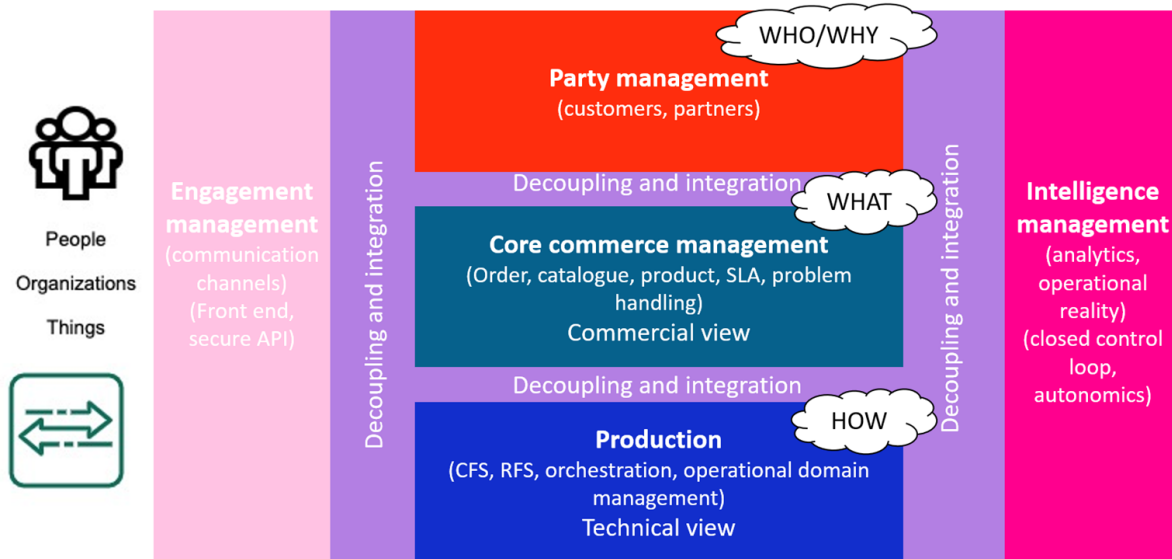


Network  
eAcademy



## Architecture & Mappings

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



### NREN mappings to date:

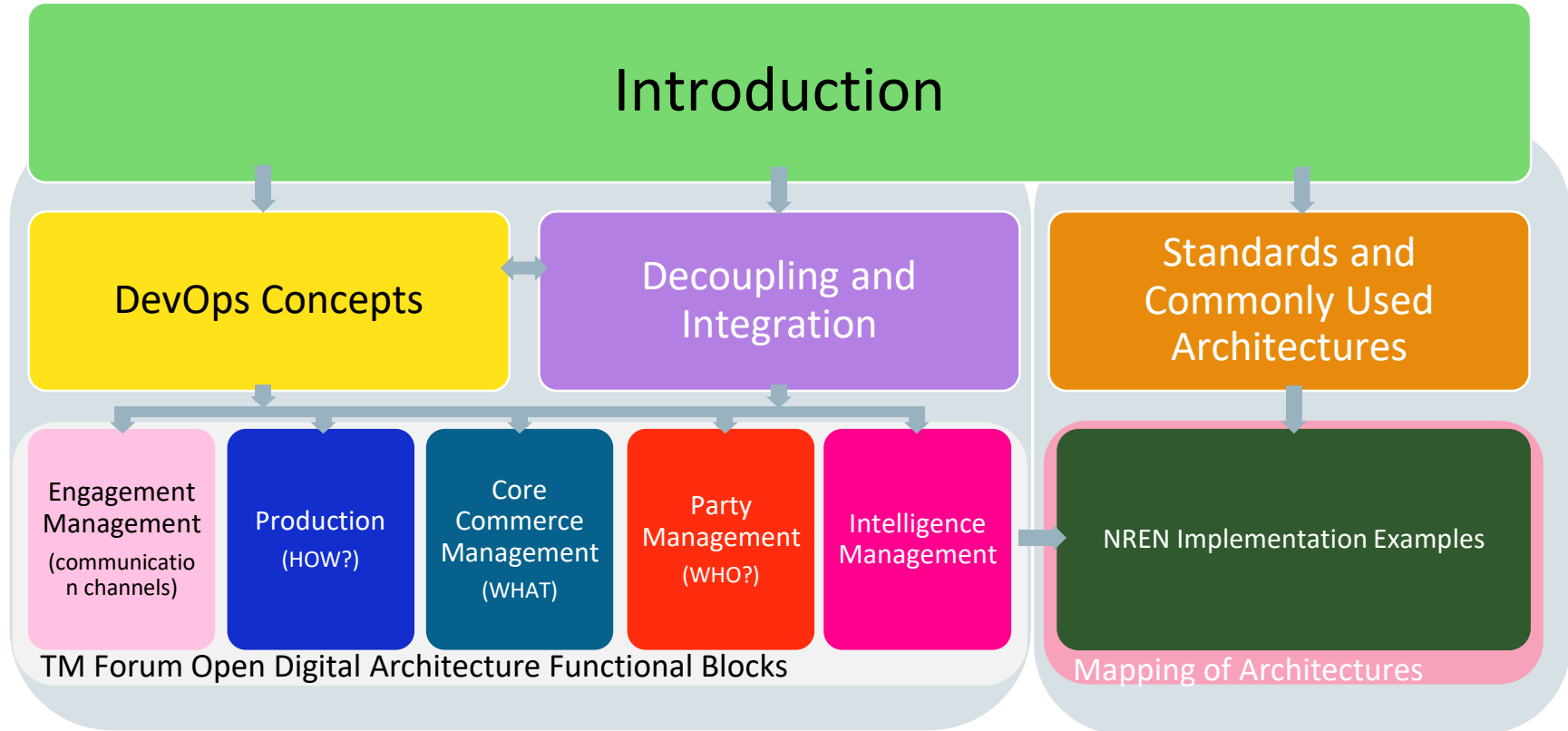
- [CARNET](#)
- [CYNET](#)
- [GÉANT](#)
- [GRNET](#)
- [HEAnet](#)
- [PIONIER](#)
- [SURFNET](#)

### Platform mappings to date:

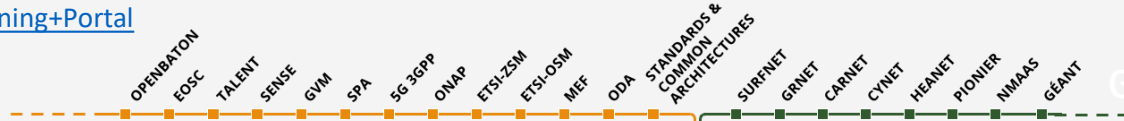
- [Argus](#)
- [NMaaS](#)
- [PMP](#)

# Knowledge Map for the Training

Training



# Network Automation eAcademy

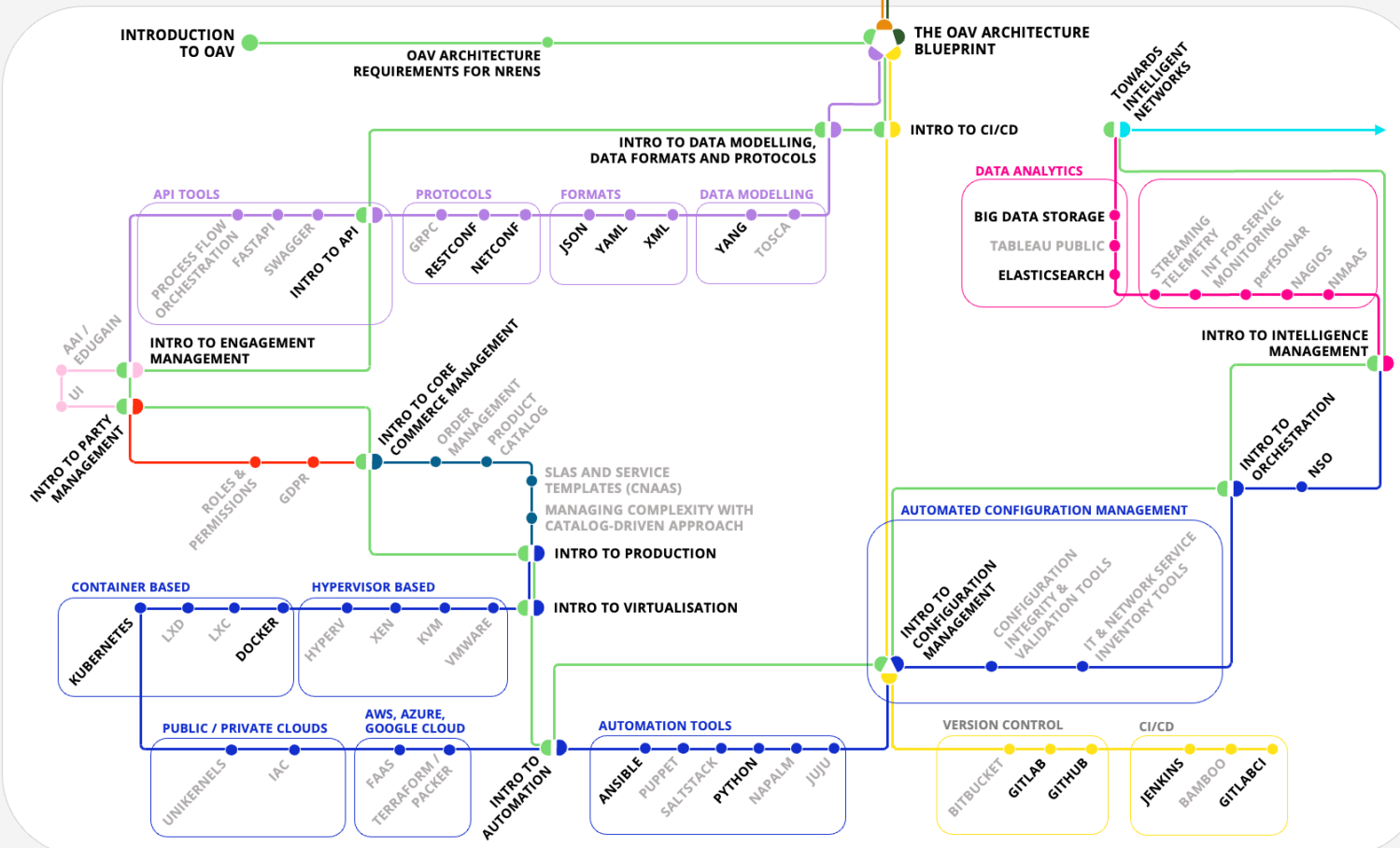


- Legend**
- Unit / ■ Document
  - Released / ● Not released
  - Exchange point
  - You can jump back and forth between this station and all exchange points at any time

### Tracks

- GENERAL INTRODUCTION
- AGILE, DevOps, CI/CD
- DECOUPLING & INTEGRATION
- PRODUCTION
- ENGAGEMENT MANAGEMENT
- PARTY MANAGEMENT
- CORE COMMERCE MANAGEMENT
- INTELLIGENCE MANAGEMENT
- OAV REALISATION
- USE CASES AND EXAMPLES
- ARCHITECTURE

Functional Blocks in the TM Forum OPEN DIGITAL ARCHITECTURE (ODA)





# General Introduction Line

## Training

Network Automation Academy  
**INTRODUCTION TO OAV**

General

30'

Network Automation Academy  
**OAV ARCHITECTURE REQUIREMENTS FOR NRENs**

General

10'

Network Automation Academy  
**THE OAV ARCHITECTURE BLUEPRINT**

General  
Open Digital Architecture

30'

Network Automation Academy  
**INTRODUCTION TO CI/CD**

General  
APIs, DevOps, CI/CD

15'

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

General  
Open Digital Architecture  
Decoupling & Integration

30'

Network Automation Academy  
**APIs: INTRODUCTION TO API**

General  
Open Digital Architecture  
Decoupling & Integration

45'

Network Automation Academy  
**INTRODUCTION TO ENGAGEMENT MANAGEMENT**

General  
Open Digital Architecture  
Engagement Management

15'

Network Automation Academy  
**INTRODUCTION TO PARTY MANAGEMENT**

General  
Open Digital Architecture  
Party Management

15'

Network Automation Academy  
**INTRODUCTION TO CORE COMMERCE MANAGEMENT**

General  
Open Digital Architecture  
Core Commerce Management

15'

Network Automation Academy  
**INTRODUCTION TO PRODUCTION**

General  
Open Digital Architecture  
Production

30'

Network Automation Academy  
**INTRODUCTION TO VIRTUALISATION**

General  
Open Digital Architecture  
Production Virtualisation

30'

Network Automation Academy  
**INTRODUCTION TO AUTOMATION**

General  
Open Digital Architecture  
Production Automation

30'

Network Automation Academy  
**AUTOMATED CONFIGURATION MANAGEMENT, INTRODUCTION TO CONFIGURATION MANAGEMENT**

General  
Open Digital Architecture  
Production Automation

30'

Network Automation Academy  
**INTRODUCTION TO ORCHESTRATION**

General  
Open Digital Architecture  
Production Orchestration

30'

Network Automation Academy  
**INTRODUCTION TO INTELLIGENCE MANAGEMENT**

General  
Open Digital Architecture  
Intelligence Management

15'

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

+Training+Portal

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

Training

Network Automation Academy

**INTRODUCTION TO DATA MODELLING, DATA FORMATS AND PROTOCOLS**

General  
Open Digital Architecture  
Decoupling & Integration

30'

Network Automation Academy

**DATA MODELLING: YANG**

Open Digital Architecture  
Decoupling & Integration

10'

Network Automation Academy

**DATA FORMATS: XML**

Open Digital Architecture  
Decoupling & Integration

60'

Network Automation Academy

**DATA FORMATS: YAML**

Open Digital Architecture  
Decoupling & Integration

30'

Network Automation Academy

**DATA FORMATS: JSON**

Open Digital Architecture  
Decoupling & Integration

45'

Network Automation Academy

**PROTOCOLS: NETCONF**

Open Digital Architecture  
Decoupling & Integration

4h (including installation)

Network Automation Academy

**PROTOCOLS: RESTCONF**

Open Digital Architecture  
Decoupling & Integration

2h

Network Automation Academy

**APIs: INTRODUCTION TO API**

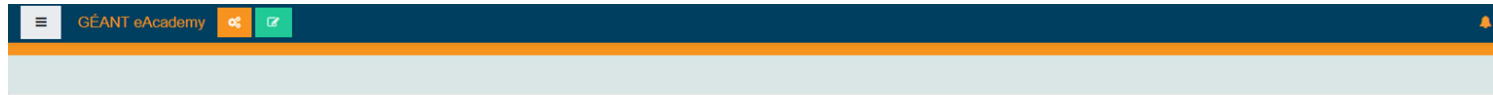
General  
Open Digital Architecture  
Decoupling & Integration

45'

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

# Ansible

## Training









## 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



|   |  |   |
|---|--|---|
| <p><b>COURSE DATE:</b></p>  <p>On Demand</p>                   | <p><b>DURATION:</b></p>  <p>60 minutes</p>    | <p><b>COMMITMENT:</b></p>  <p>60 minutes + lab time</p> |
| <p><b>REQUIREMENT:</b></p>  <p><b>YAML Learning Module</b></p> | <p><b>COURSE TYPE:</b></p>  <p>Self-paced</p> | <p><b>CREDENTIAL:</b></p>  <p>Certificate</p>           |

|                 |                            |
|-----------------|----------------------------|
| 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,

<https://e-academy.geant.org/moodle/course/view.php?id=120>

# Ansible Requirement: YAML, YAML Requirement?

GEANT 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



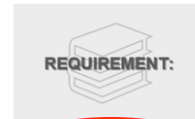
**DURATION:**

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

☰
GÉANT eAcademy

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## Data modelling, data formats and protocols - Introduction

Home
My courses
Technical skills
Network
Network Automation eAcademy
Introduction to data modeling, 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  
Networking & Integration

**COURSE DATE:**

From January 2021

**DURATION:**

20 minutes

**COMMITMENT:**

30 minutes

**REQUIREMENT:**

None

**COURSE TYPE:**

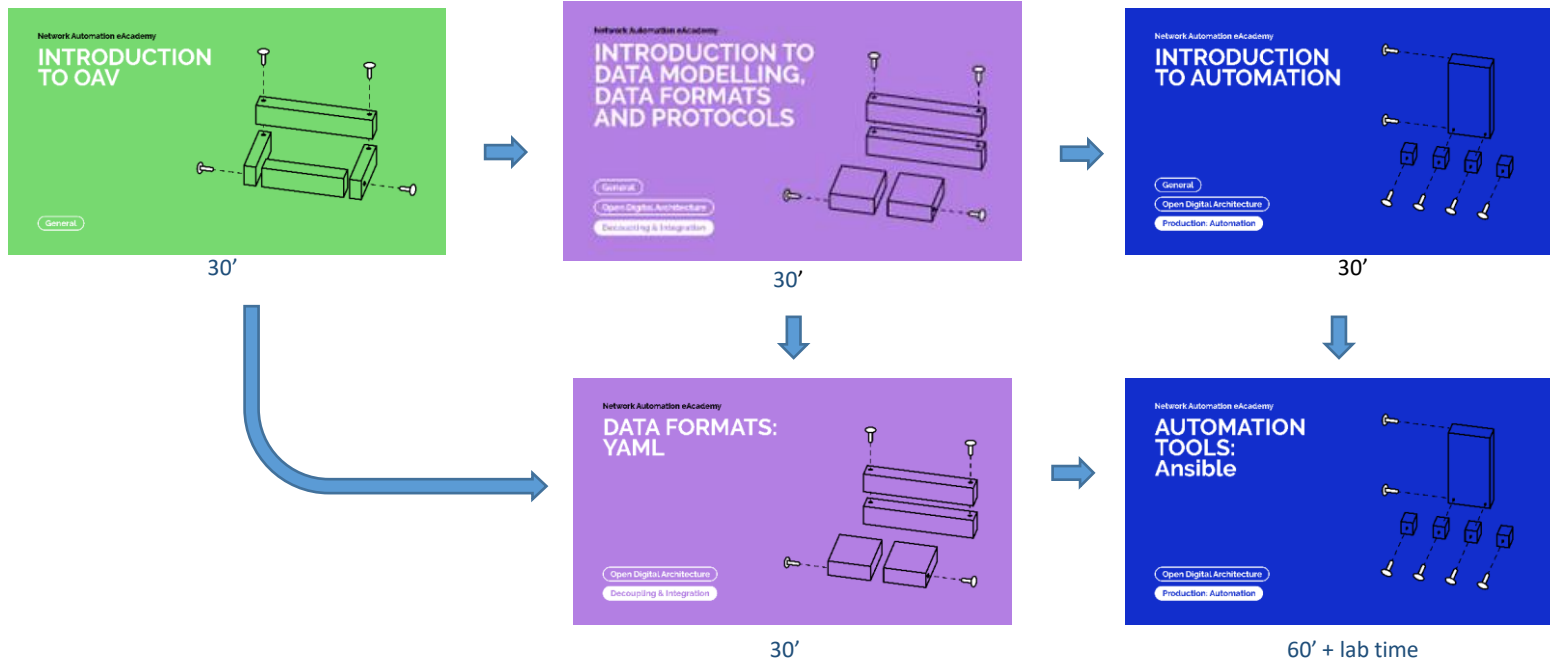
Self-paced

**CREDENTIAL:**

Certificate of Completion

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

# Ansible



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

# Ansible: Video with Subtitles

☰ GÉANT 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 | Fee

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 webservers
  hosts: webservers
  become: true
  tasks:
    - name: Install Apache
      apt: pkg=apache2 state=latest

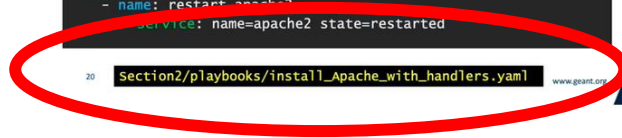
    - name: enable mod_rewrite
      apache2_module: name=rewrite state=present
      notify:
        - restart_apache2

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

```

www.geant.org

 [Ansible section II - slides and speaker notes PDF document](#)



# Ansible: Slides with Speaker Notes

GEANT eAcademy

## Ansible

Home > My courses > Technical slide > Network > ...

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

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
- Understand Ansible's use of variables and how to reference their
- Understand Ansible's `host_vars/group_vars` directory structure
- Understand what modules do and how to use them in playbooks

## 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
  
```

5

www.geant.org



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

ansible section II - slides and speaker notes PDF document



# 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')
- [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)

### 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')
- [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')
- [Introduction to Orchestration](#) (30')
- [Orchestration: NSO](#) (6h - including lab)

### Intelligence Management

- [Introduction to Intelligence Management](#) (15')

### Data Analytics

- [Big Data Storage](#) (1.5h)
- [Elasticsearch](#) (30')

## OAV Realisation

- [Towards Intelligent Networks](#) (30')

## ADDITIONAL READING

### Architecture Mappings

#### NREN use cases

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

#### other use cases

- [NMaaS](#)

### Architectures

- [Standards & Common Architectures](#)
- [TM Forum ODA](#)
- [SPA](#)
- [MEF](#)
- [ETSI-OSM](#)
- [ETSI-ZSM](#)
- [ONAP](#)
- [5G 3GPP](#)
- [GVM](#)
- [SENSE](#)
- [TALENT](#)
- [EOSC](#)
- [OpenBaton](#)

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

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- **CI/CD: GitlabCI** (40')

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eduGAIN access  
(or social media)



## TM Forum Open Digital Architecture

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  - CYNET
  - GÉANT
  - GRNET
  - HEAnet
  - PIONIER
  - SURFNET
- other use cases
  - NMaaS

### Architectures

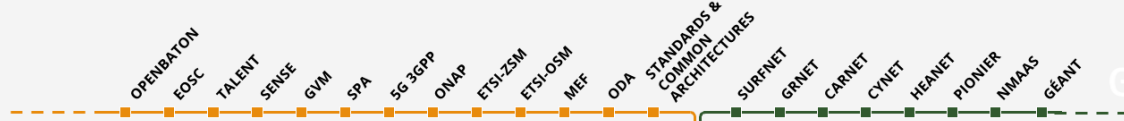
- **Standards & Common Architectures**
- **TM Forum ODA**
- **SPA**
- **MEF**
- **ETSI-OSM**
- **ETSI-ZSM**
- **ONAP**
- **5G 3GPP**
- **GVM**
- **SENSE**
- **TALENT**
- **EOSC**
- **OpenBaton**

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

## Practical Examples

- Ansible:
  - Git repository with the examples in the unit.
  - Mini-Lab: Vagrant testing environment with a Unix server and a JunOS box.
- NETCONF:
  - Installation guide with a virtual environment in GNS3.
  - Adding a static route to a router, step-by-step.
- NSO:
  - Installation of free trial version.
  - Implementing a Radius server configuration over multiple devices.
  - Deploying an ACL on multiple devices, and/or interfaces on a device.

# Network Automation eAcademy in progress

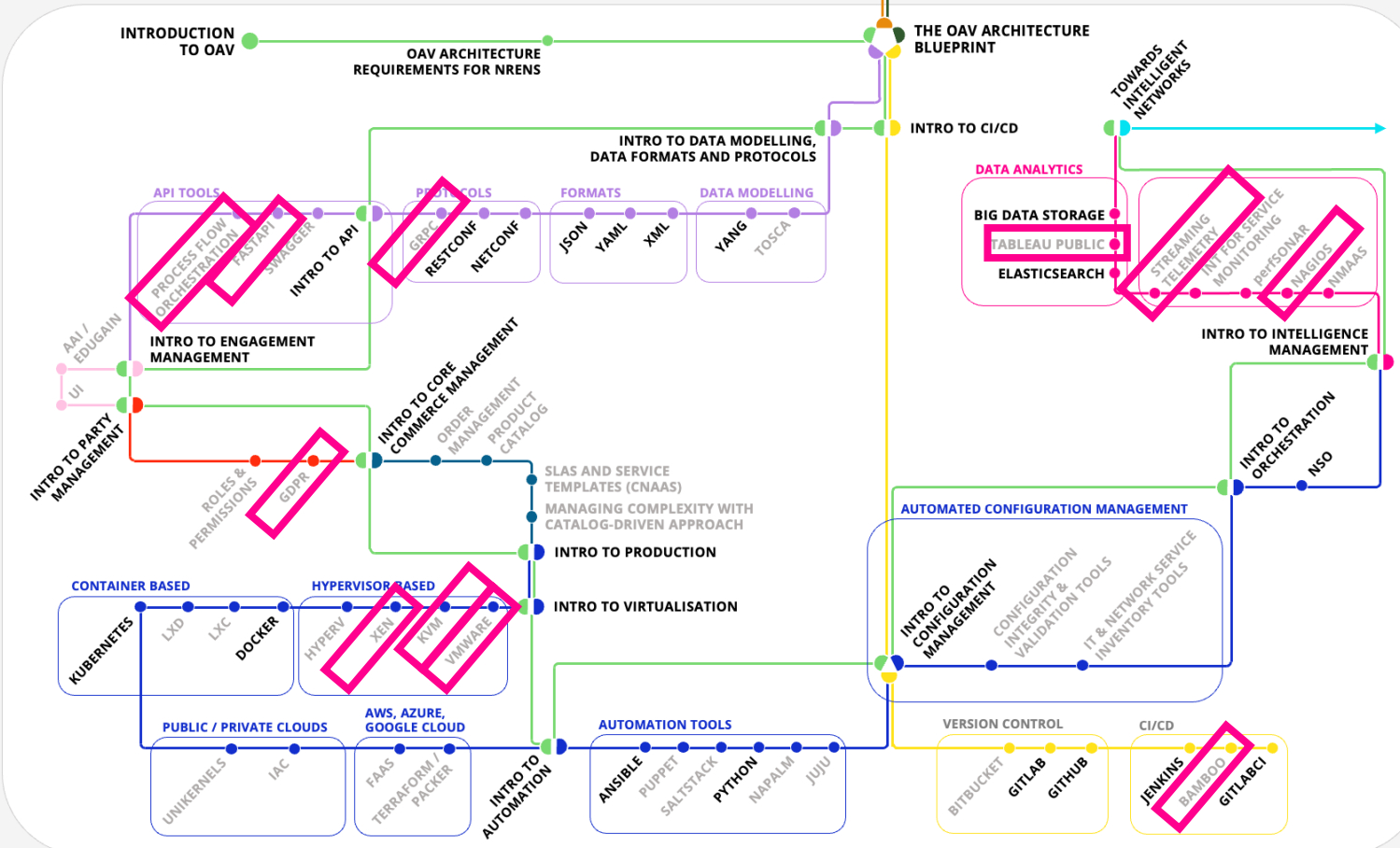


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- PRODUCTION
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- PARTY MANAGEMENT
- CORE COMMERCE MANAGEMENT
- INTELLIGENCE MANAGEMENT
- OAV REALISATION
- USE CASES AND EXAMPLES
- ARCHITECTURE

Functional Blocks in the TM Forum OPEN DIGITAL ARCHITECTURE (ODA)

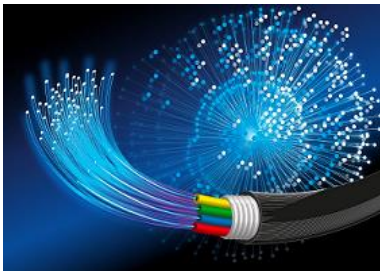


## Currently Working on Training for:

Training



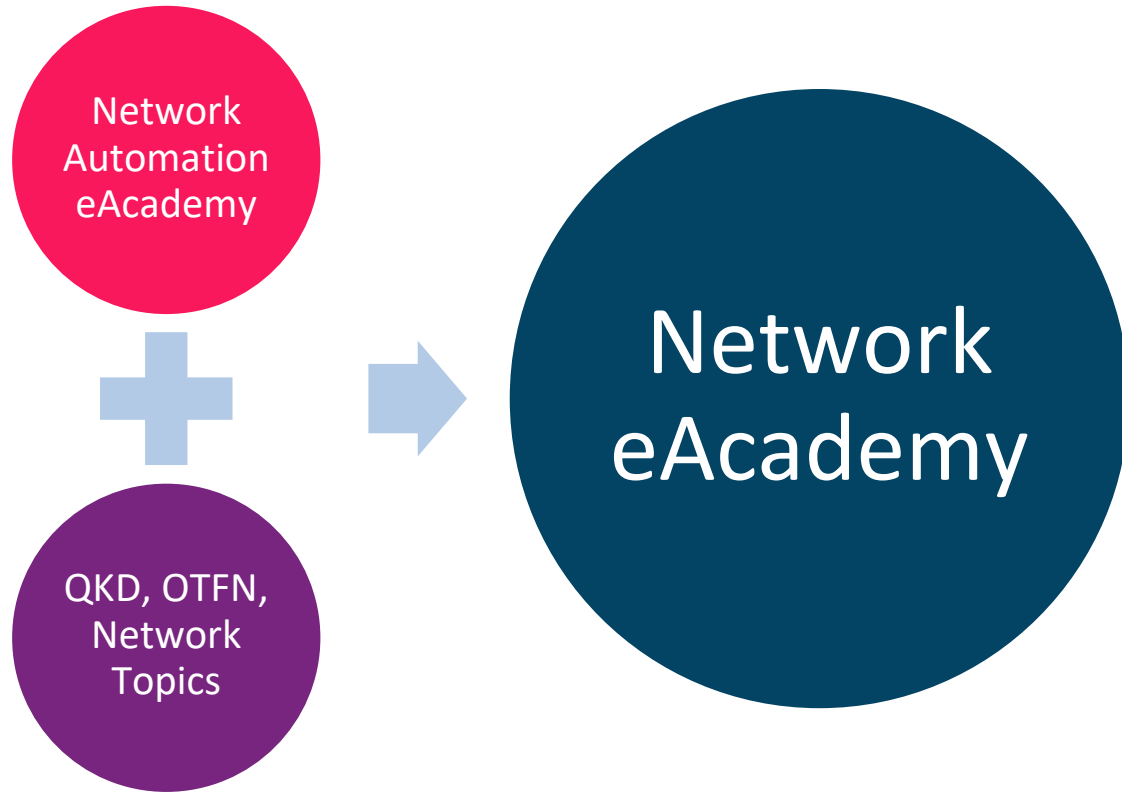
[Optical Time and Frequency Networks \(OTFN\)](#)



[Quantum Technologies](#)

## The Network eAcademy

Network  
eAcademy



# Current Courses in the Network eAcademy – Quantum

Training



Quantum Algebra: Bloch Sphere

Course creator: Peter Kaufmann



Quantum Algebra: Entanglement Swapping

Course creator: Peter Kaufmann



Quantum Algebra: Mathematical Operators

Course creator: Peter Kaufmann



Quantum Algebra: Operator Multiplication: Variants

Course creator: Peter Kaufmann



Quantum Algebra: Qubit Entanglement

Course creator: Peter Kaufmann



Quantum Algebra: Qubits

Course creator: Peter Kaufmann



Quantum Algebra: Teleportation



Quantum Computers



Quantum Computing and Post-Quantum Cryptography

# Currently working on – Quantum **in progress**

Training



Quantum Algebra: Bloch Sphere

Course creator: Peter Kaufmann



Quantum Algebra: Entanglement Swapping

Course creator: Peter Kaufmann



Quantum Algebra: Mathematical Operators

Course creator: Peter Kaufmann



Quantum Algebra: Operator Multiplication: Variants

Course creator: Peter Kaufmann



Quantum Algebra: Qubit Entanglement

Course creator: Peter Kaufmann



Quantum Algebra: Qubits

Course creator: Peter Kaufmann



Quantum Algebra: Teleportation



Quantum Computers



Quantum Computing and Post-Quantum Cryptography





## Terminology and Glossary of OAV Terms

- Need for an agreement on common terminology.
- The idea is to have a common ground of understanding.
- Published [version](#) 2.0 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   |
|--|--|
| <b>AIOps</b>                                   | <p><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></p> <ul style="list-style-type: none"> <li>• <a href="https://www.gartner.com/en/information-technology/glossary/aiops-artificial-intelligence-operations">https://www.gartner.com/en/information-technology/glossary/aiops-artificial-intelligence-operations</a></li> </ul>  |
| <b>AI-powered Virtual Agent (AIVA)</b>         | <p><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></p> <ul style="list-style-type: none"> <li>• <b>Reference(s):</b> based on <a href="https://www.ringcentral.com/virtual-agent.html">https://www.ringcentral.com/virtual-agent.html</a> and TM Forum AI Fundamentals course [TMF_AIF] and TM Forum "AI and its pivotal role in transforming operations" report and webinar [TMF_AI]</li> </ul> |
| <b>API</b> (Application Programming Interface) | <p><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></p>  |

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



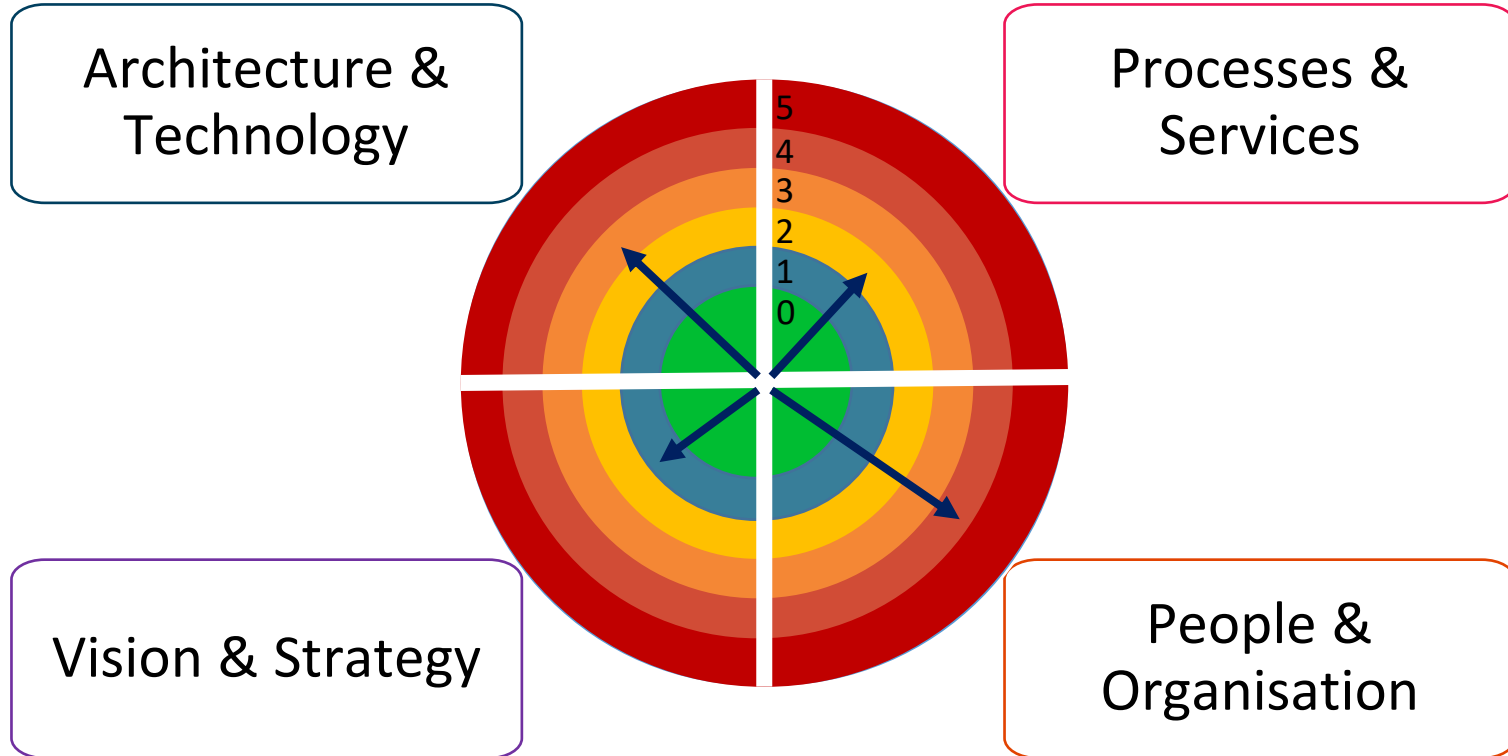
## OAV Maturity Model

### 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



# OAV Maturity Model - Stages

Maturity Model



## The Maturity Model

### Maturity Model

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Survey (31 questions)\*:

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

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

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

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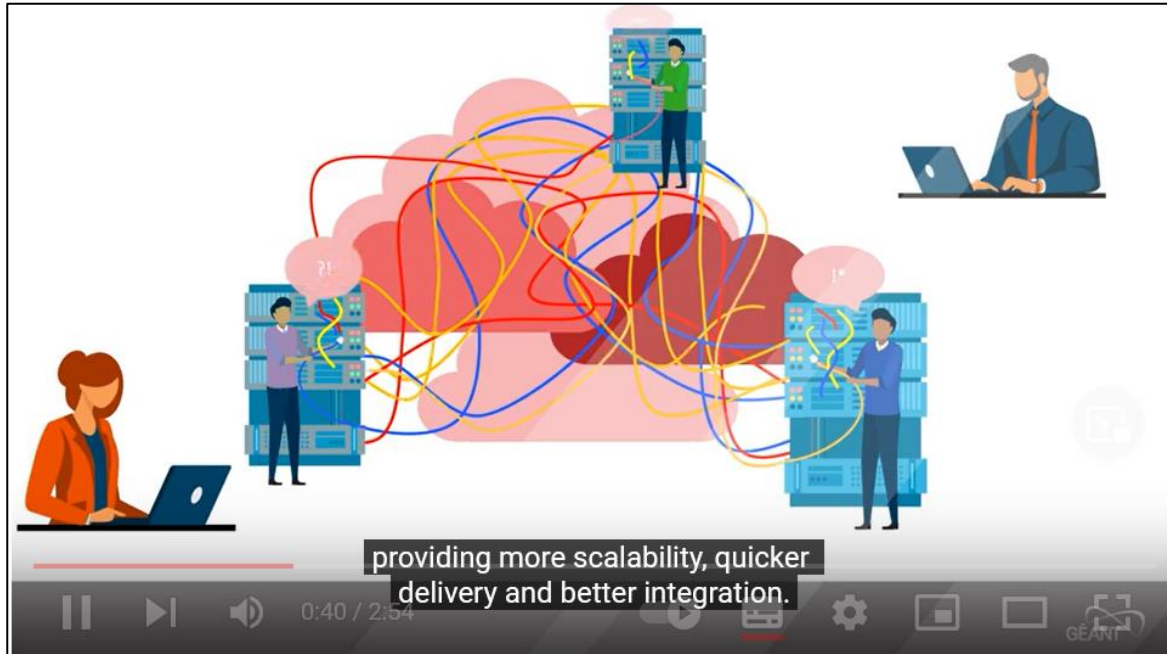
Presentations of the OAV MM Infoshare:

<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)

## 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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## THE AUTOMATION, ORCHESTRATION AND VIRTUALISATION JOURNEY



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  
Use orchestrators to implement complex processes spanning multiple components

### VIA A DIGITAL PLATFORM

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

### 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 Veges 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

### OAV Wiki Knowledge Base

|                  |   |
|------------------|---|
| Terminology      | <a href="https://wiki.geant.org/display/NETDEV/OAV+Terminology">https://wiki.geant.org/display/NETDEV/OAV+Terminology</a>           |
| Community Portal | <a href="https://wiki.geant.org/display/NETDEV/OAV+Community+Portal">https://wiki.geant.org/display/NETDEV/OAV+Community+Portal</a> |
| White paper      | <a href="https://wiki.geant.org/display/NETDEV/OAV+Architectures">https://wiki.geant.org/display/NETDEV/OAV+Architectures</a>       |



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



Contact us at [oav@lists.geant.org](mailto:oav@lists.geant.org)

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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, facilitates 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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## TOWARDS COLLABORATIVE DIGITAL 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](https://www.geant.org/Resources/Documents/OAV_Arch_text_and_infographics_new_links.pdf)

# Wiki

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

| 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  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>AARNET, Australia</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="https://www.aarnet.edu.au/">https://www.aarnet.edu.au/</a></li> <li>• Hendrik Buining, David Jencho. Orchestration, Automation and Virtualisation, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf)</li> </ul>  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>ARNES</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="https://www.arnes.si/">https://www.arnes.si/</a></li> <li>• 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).</li> <li>• They have built the ARNES network service orchestration stack, automation based on Ansible.</li> <li>• <a href="https://geant.lapp.bos.com/A/6892sq4kbo9683j8qybg05du7jhtz">https://geant.lapp.bos.com/A/6892sq4kbo9683j8qybg05du7jhtz</a></li> </ul>   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>CARNET</b>  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="https://www.carnet.hr/">https://www.carnet.hr/</a></li> <li>• Damir Regvar, Lidija Jakovčić, Šiljica Mišić. CARNET OAV, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf)</li> <li>• CARNET is also working on a national project to offer wireless connection within the schools in the country (<a href="https://www.e-skole.hr/en/results/adequate-ict-infrastructure-in-pilot-schools/">https://www.e-skole.hr/en/results/adequate-ict-infrastructure-in-pilot-schools/</a>), with a network management system built by them (Management system for the educational system). CARNET does the network provisioning and monitoring through an API: <a href="https://geant.lapp.bos.com/A/95tdtbv2dhuuffd137k7mj906mm16">https://geant.lapp.bos.com/A/95tdtbv2dhuuffd137k7mj906mm16</a></li> <li>• See the lightning talk during the Network Management and Monitoring Workshop.</li> </ul> |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>CSUC</b>  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="https://www.csuc.cat">https://www.csuc.cat</a></li> <li>• CSUC has automated the provisioning of new circuits in the L2 and L3 devices using Rundeck, Python scripts and Ansible modules for Anella Científica (Regional Research and Education Network in Catalonia).</li> <li>• 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.</li> </ul>   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>CyNet</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="http://www.cynet.se.cy/">http://www.cynet.se.cy/</a></li> <li>• <a href="https://www.geant.org/Resources/Documents/GN4-3_White-Paper_CYNET_OAV_Architecture_Analysis.pdf">https://www.geant.org/Resources/Documents/GN4-3_White-Paper_CYNET_OAV_Architecture_Analysis.pdf</a></li> <li>• Iakovos Ioannou. Active member of OAV working group of WP6-T2.</li> </ul>   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>ESnet, USA</b>  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="http://es.net/">http://es.net/</a></li> <li>• John MacAuley. Service orchestration in ESnet6, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf)</li> </ul>   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>FUNET</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="https://www.csc.fi/funet-kaikki-palvelut">https://www.csc.fi/funet-kaikki-palvelut</a></li> <li>• Asko Hakala. Workshop on Network Management and Monitoring, Copenhagen, October 2019: <a href="https://wiki.geant.org/download/attachments/131629403/Funet%20Kampus%20Service.pdf?version=1&amp;modificationDate=1571047052723&amp;api=v2">https://wiki.geant.org/download/attachments/131629403/Funet%20Kampus%20Service.pdf?version=1&amp;modificationDate=1571047052723&amp;api=v2</a>.</li> <li>• Kampus Service Project. All new customer provisioning is automated, with no manual configuration (only physical installation).</li> <li>• Everything automated using Ansible, configuration stored in YAML files.</li> </ul>   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>GEANT</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | <ul style="list-style-type: none"> <li>• <a href="https://www.geant.org/">https://www.geant.org/</a></li> <li>• Bram Peeters. Orchestration, Automation and Virtualisation (OAV) in GEANT, GN4-3 Future Service Strategy Workshop, Amsterdam, May 9, 2019 (pdf)</li> <li>• Mian Usman. Orchestration and Automation, BOF, TNC19, Tallinn, Estonia, June 20, 2019 (pdf)</li> <li>• Tony Barber. 10th SIG-NOC meeting presentation</li> </ul>  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



## With Many Thanks to our Trainers!

|                                      |                                     |
|--------------------------------------|-------------------------------------|
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| Nicolai Iliuha (RENAM)               | Kostas Stamos (GRNET / CTI)         |
| Iacovos Ioannou (CyNet)              | Your name here?                     |



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And the WPL, the GLAD team and the Communications team at GÉANT!

For any questions, the R&E community can join us once a month.



# Thank You!

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