



# Network (Automation) eAcademy

**Maria Isabel Gandia, CSUC/RedIRIS**  
*WP6-T2*

ACONET Conference

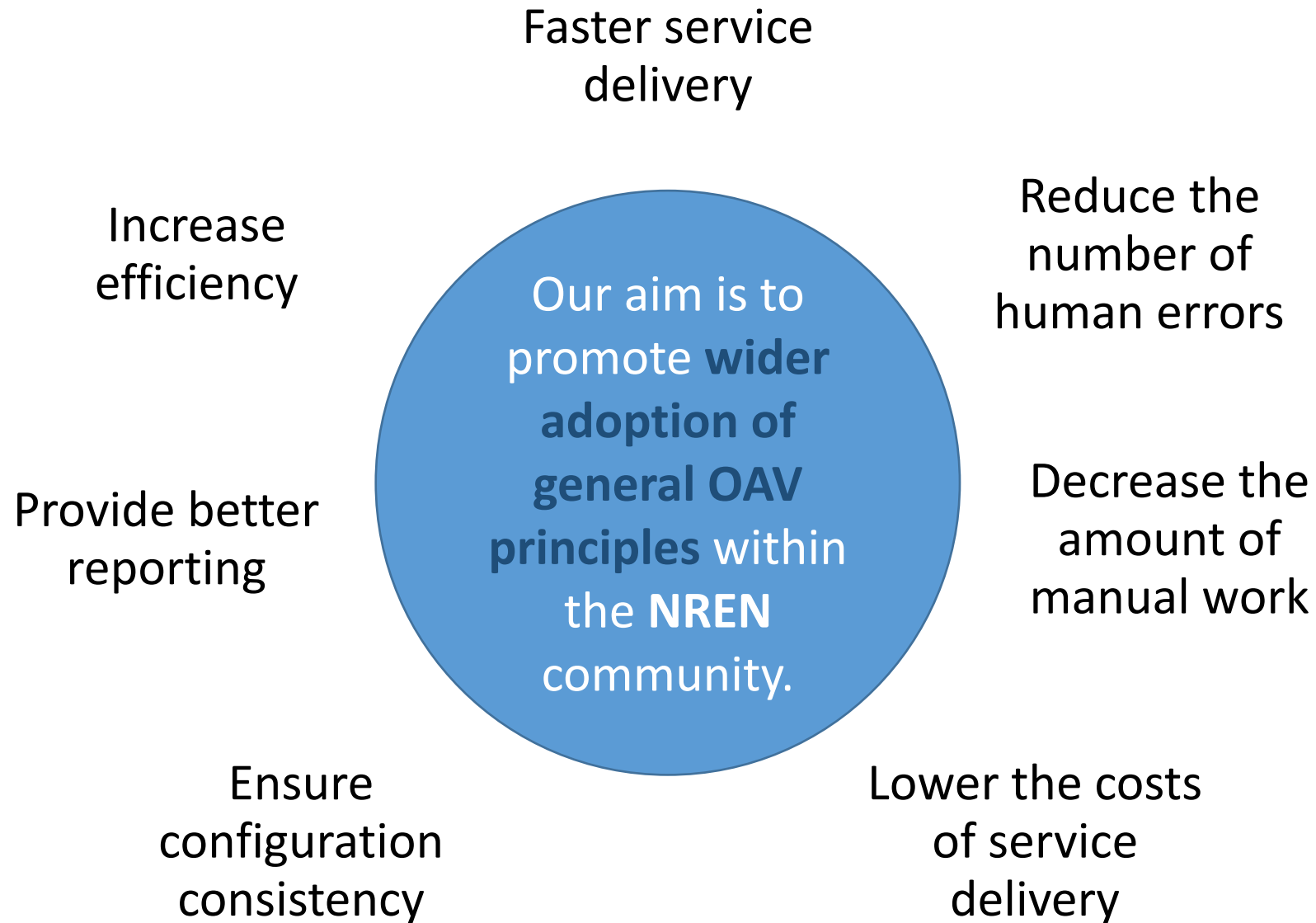
University of Viena, 24 November 2022

[www.geant.org](http://www.geant.org)

# Agenda: Network (Automation) eAcademy

- Introduction: Orchestration, Automation and Virtualisation in GN4-3
- Architecture/Mapping
- Training
- Terminology
- Maturity Model
- Wiki and dissemination
- What next?

# 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



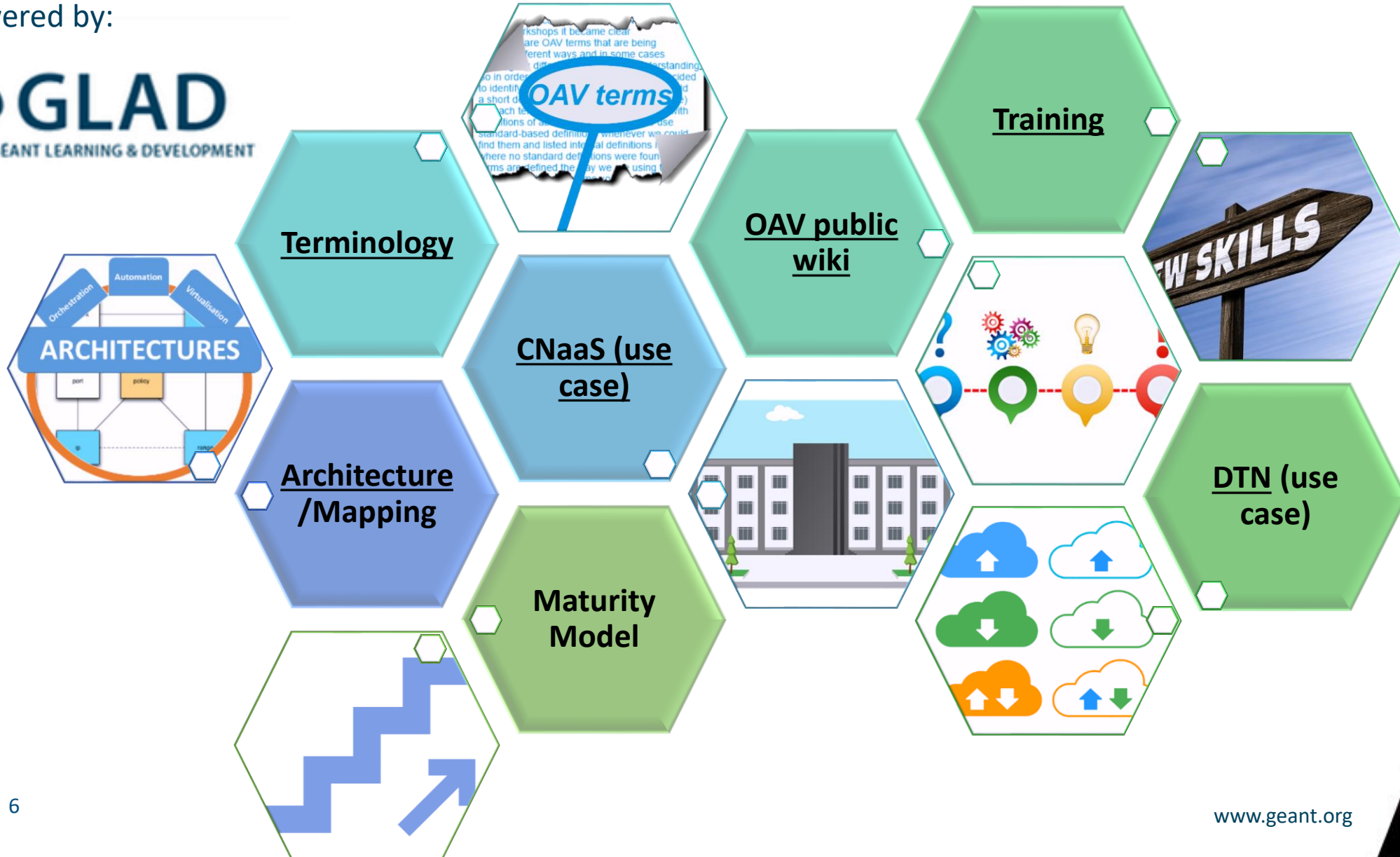
A generally accepted architecture blueprint needed



NRENs are willing to share experiences and learn from others

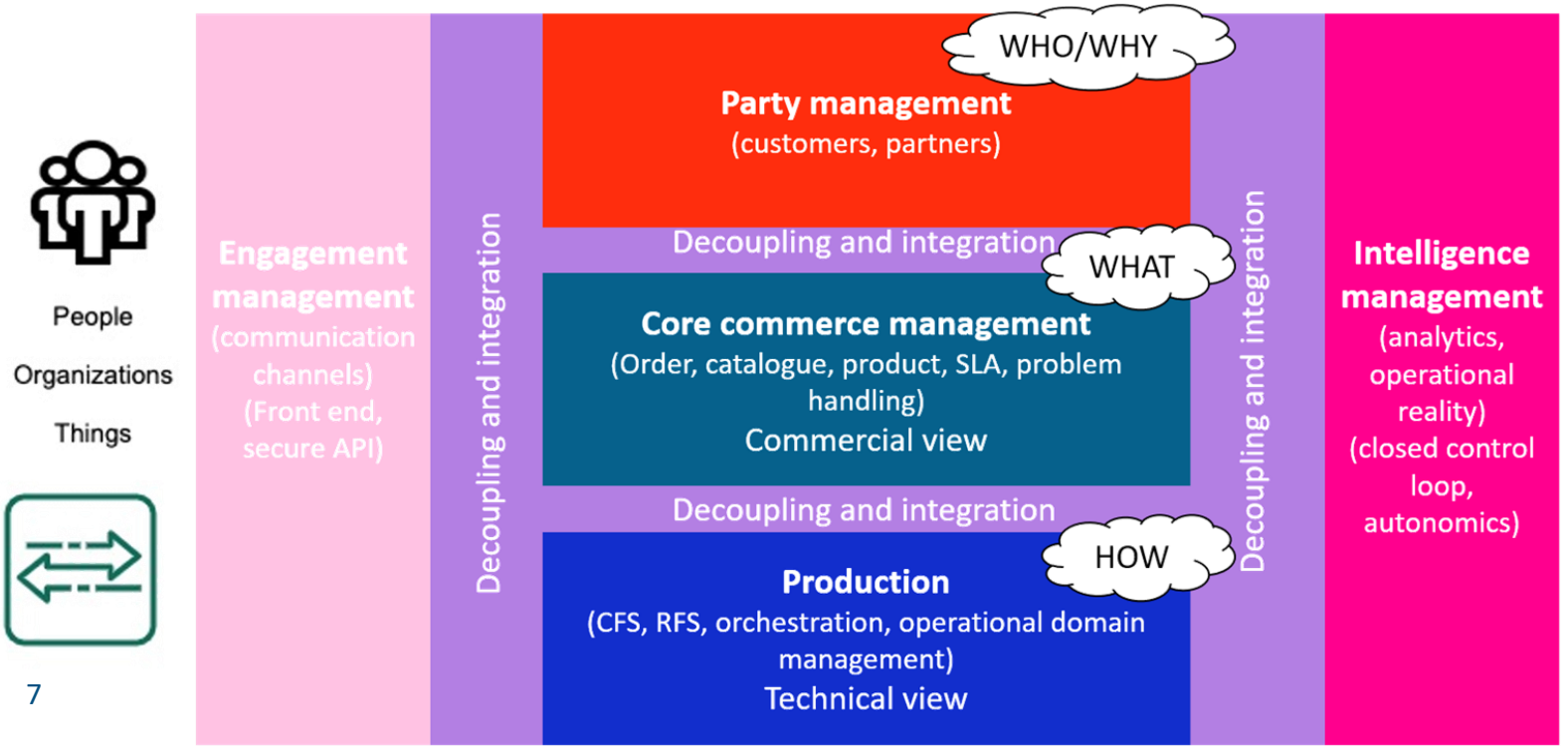
# Network Automation eAcademy

Powered by:



# Architecture & Mappings

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



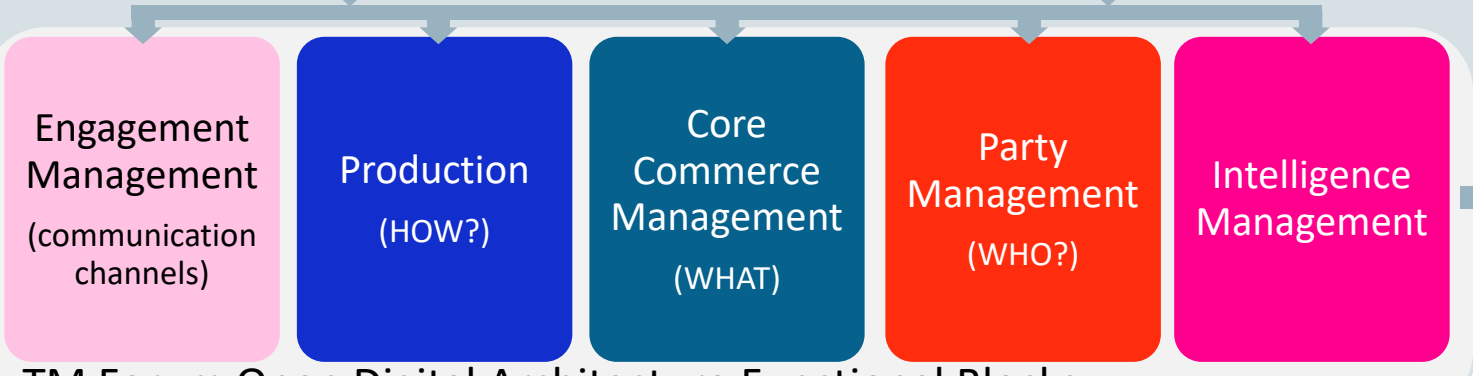
### NREN use cases

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

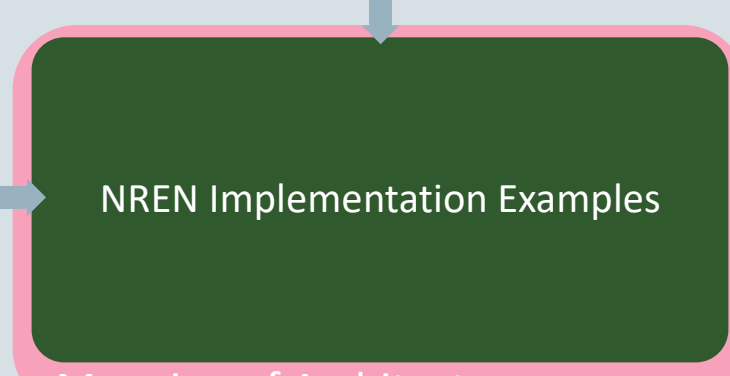
### other use cases

- NMaaS

## Introduction



TM Forum Open Digital Architecture Functional Blocks



Mapping of Architectures



# Network Automation eAcademy



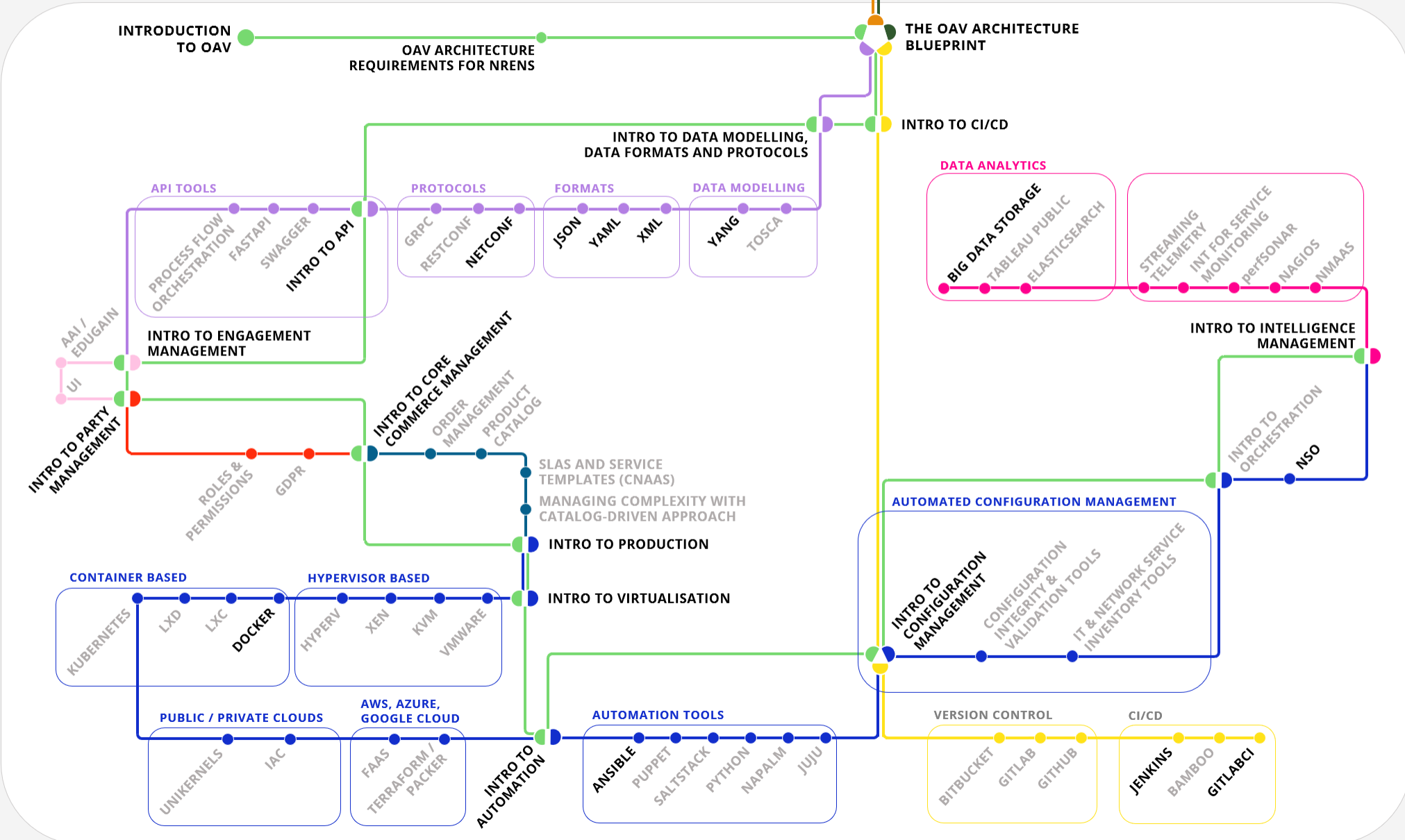
- Legend**
- Unit / ■ Document
  - Released / ● Not released

Exchange point

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

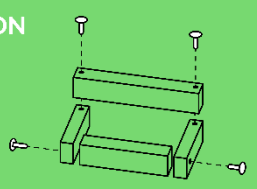
- Tracks**
- GENERAL INTRODUCTION
  - AGILE, DevOps, CI/CD
  - DECOUPLING & INTEGRATION
  - PRODUCTION
  - ENGAGEMENT MANAGEMENT
  - PARTY MANAGEMENT
  - CORE COMMERCE MANAGEMENT
  - INTELLIGENCE MANAGEMENT
  - USE CASES AND EXAMPLES
  - ARCHITECTURE

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



# General Introduction Line

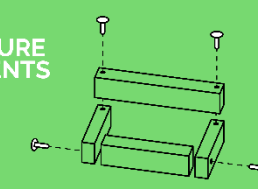
Network Automation eAcademy  
**INTRODUCTION TO OAV**



General

30'

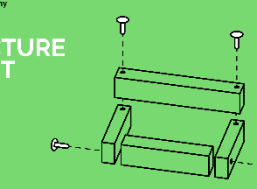
Network Automation eAcademy  
**OAV ARCHITECTURE REQUIREMENTS FOR NRENS**



General

10'

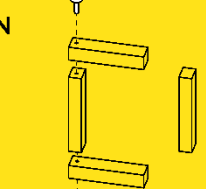
Network Automation eAcademy  
**THE OAV ARCHITECTURE BLUEPRINT**



General  
Open Digital Architecture

30'


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



General  
Agile, DevOps, CI/CD

15'

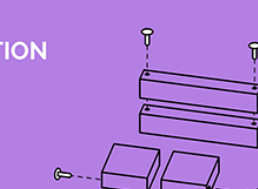
Network Automation eAcademy  
**INTRODUCTION TO DATA MODELLING, DATA FORMATS AND PROTOCOLS**



General  
Open Digital Architecture  
Decoupling & Integration

30'

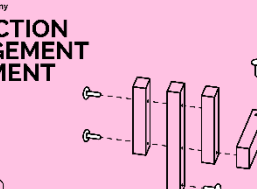
Network Automation eAcademy  
**APIs: INTRODUCTION TO API**



General  
Open Digital Architecture  
Decoupling & Integration

45'

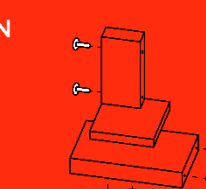
Network Automation eAcademy  
**INTRODUCTION TO ENGAGEMENT MANAGEMENT**



General  
Open Digital Architecture  
Engagement Management

15'

Network Automation eAcademy  
**INTRODUCTION TO PARTY MANAGEMENT**



General  
Open Digital Architecture  
Party Management

15'

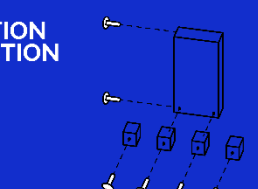
Network Automation eAcademy  
**INTRODUCTION TO CORE COMMERCE MANAGEMENT**



General  
Open Digital Architecture  
Core Commerce Management

15'

Network Automation eAcademy  
**INTRODUCTION TO PRODUCTION**



General  
Open Digital Architecture  
Production

30'

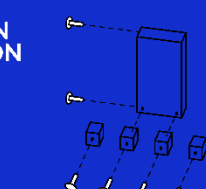
Network Automation eAcademy  
**INTRODUCTION TO VIRTUALISATION**



General  
Open Digital Architecture  
Production: Virtualisation

30'

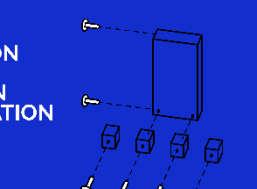
Network Automation eAcademy  
**INTRODUCTION TO AUTOMATION**



General  
Open Digital Architecture  
Production: Automation

30'

Network Automation eAcademy  
**AUTOMATED CONFIGURATION MANAGEMENT: INTRODUCTION TO CONFIGURATION MANAGEMENT**



General  
Open Digital Architecture  
Production: Automation

30'

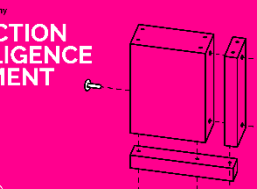
Network Automation eAcademy  
**INTRODUCTION TO ORCHESTRATION**



General  
Open Digital Architecture  
Production: Orchestration

30'

Network Automation eAcademy  
**INTRODUCTION TO INTELLIGENCE MANAGEMENT**



General  
Open Digital Architecture  
Intelligence Management

15'

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

Network Automation eAcademy

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

General  
Open Digital Architecture  
Decoupling & Integration

30'

Network Automation eAcademy

### DATA MODELLING: YANG

Open Digital Architecture  
Decoupling & Integration

10'

Network Automation eAcademy

### DATA FORMATS: XML

Open Digital Architecture  
Decoupling & Integration

60'

Network Automation eAcademy

### DATA FORMATS: YAML

Open Digital Architecture  
Decoupling & Integration

30'

Network Automation eAcademy

### DATA FORMATS: JSON

Open Digital Architecture  
Decoupling & Integration

45'

Network Automation eAcademy

### PROTOCOLS: NETCONF

Open Digital Architecture  
Decoupling & Integration

4h (including installation)

Network Automation eAcademy

### PROTOCOLS: RESTCONF

Open Digital Architecture  
Decoupling & Integration

Network Automation eAcademy

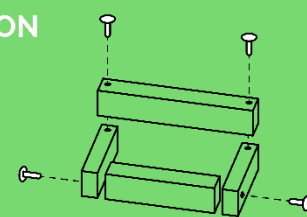
### APIs: INTRODUCTION TO API

General  
Open Digital Architecture  
Decoupling & Integration

45'

# Ansible

Network Automation eAcademy  
**INTRODUCTION TO OAV**




General

30'



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

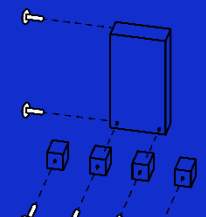


General  
Open Digital Architecture  
Decoupling & Integration

30'



Network Automation eAcademy  
**INTRODUCTION TO AUTOMATION**

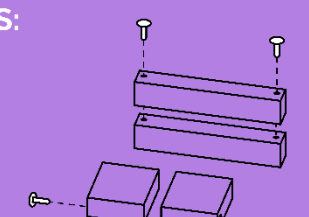


General  
Open Digital Architecture  
Production: Automation

30



Network Automation eAcademy  
**DATA FORMATS: YAML**

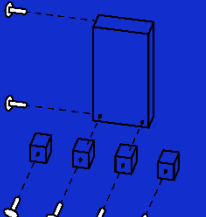


Open Digital Architecture  
Decoupling & Integration

30'

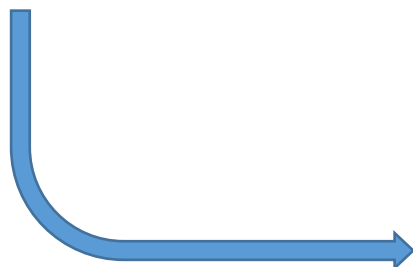


Network Automation eAcademy  
**AUTOMATION TOOLS: Ansible**



Open Digital Architecture  
Production: Automation

60' + lab time



# Current Courses in the Network Automation eAcademy

## Introduction

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

## DevOps

- **Introduction to CI/CD** (15')
- **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')

### 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)
- **Introduction to Automation** (30')
- **Automation Tools: Ansible** (60'+lab time)
- **Introduction to Configuration Management** (20')
- **Orchestration: NSO** (6h - including lab)

### Intelligence Management

- **Introduction to Intelligence Management** (15')
- **Big Data Storage** (1.5h)

## ADDITIONAL READING

### Architecture Mappings

#### NREN use cases

- **CARNET**
- **CYNET**
- **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**

www.geant.org

# Ansible

## Ansible

Welcome to the Course: Ansible



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



## 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



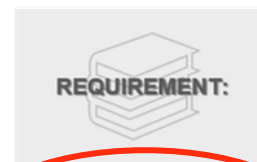
From September 2021



20 min



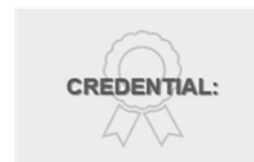
30 min



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



Selfpaced



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.

15 For more detail, the learning unit discusses the following topics:

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

www.geant.org

# Ansible ← YAML ← Data models, Data Formats, and Protocols

The screenshot shows the GÉANT eAcademy interface. At the top, there's a navigation bar with 'GÉANT eAcademy' and icons for home, search, and user profile. Below this is a breadcrumb trail: Home > My courses > Technical skills > Network > Network Automation eAcademy > Introduction to data modelling, data formats and protocols. The main content area has a tabbed interface with 'OVERVIEW' selected. Under 'OVERVIEW', there are links for Main Goals, Course Materials, Definitions, Data Modelling, Data Formats, Protocols, Links, Quiz, and Feedback Form & Certificate of Completion. A welcome message reads: 'Welcome to the Introduction to Data Modelling, Data Formats and Protocols learning unit'. Below this is a course card with a purple background and the title 'INTRODUCTION TO DATA MODELLING, DATA FORMATS AND PROTOCOLS'. To the right of the card are six key metrics: COURSE DATE (From January 2021), DURATION (20 minutes), COMMITMENT (30 minutes), REQUIREMENT (None), COURSE TYPE (Self-paced), and CREDENTIAL (Certificate of Completion). At the bottom left, there is a table with learning path information.

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



# 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
    
```

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

GÉANT 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.

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
        
```

www.geant.org GÉANT

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

## Practical Examples

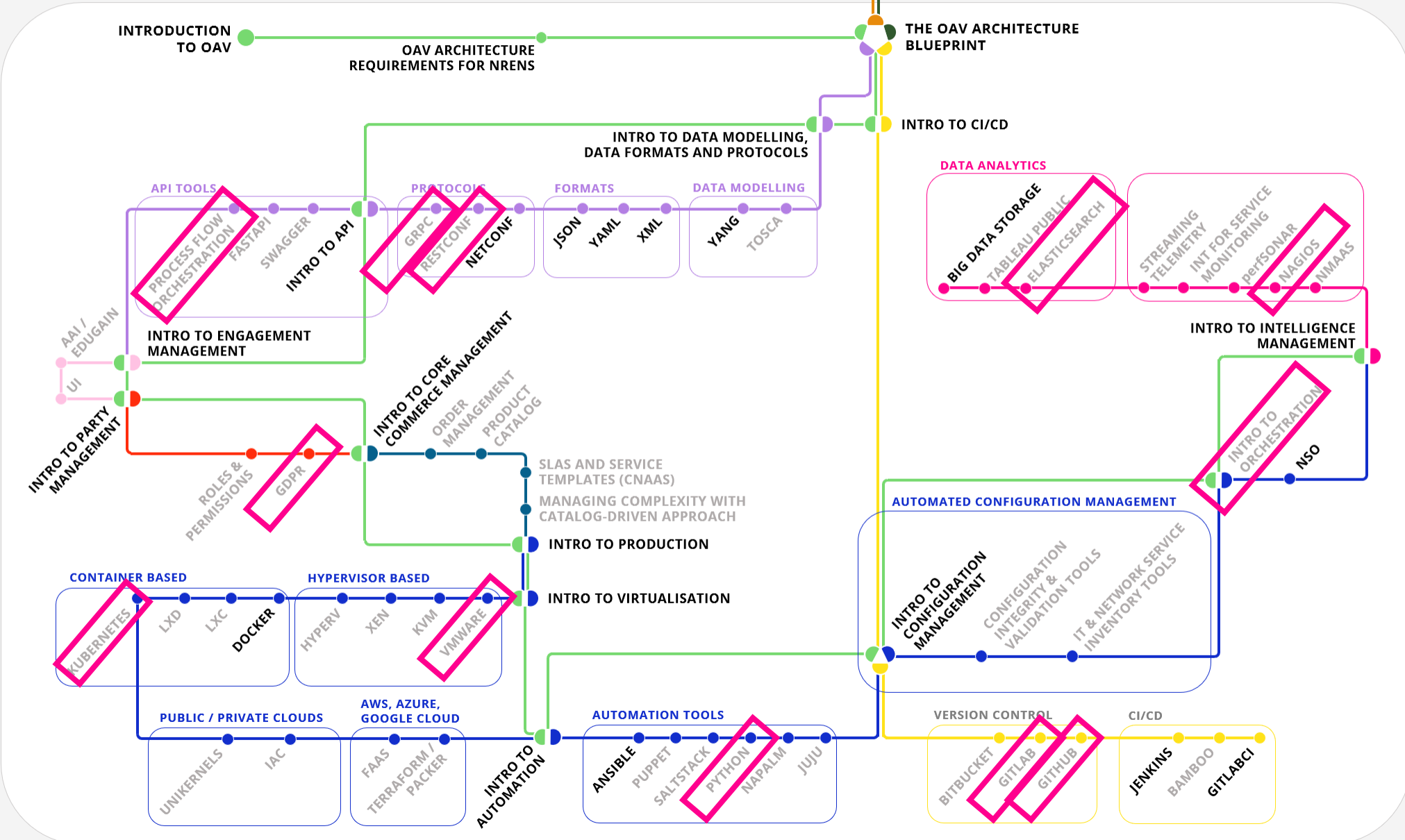
- Ansible:
  - Git repository with the examples in the unit.
  - Mini-Lab: Vagrant testing environment with a Unix server and a JunOS box.
- NETCONF:
  - Installation guide with a virtual environment in GNS3.
  - Adding a static route to a router, step-by-step.
- NSO:
  - Installation of free trial version.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

# Currently Working on 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
  - USE CASES AND EXAMPLES
  - ARCHITECTURE
- Functional Blocks in the TM Forum OPEN DIGITAL ARCHITECTURE (ODA)



# Terminology and Glossary of OAV Terms

- Published version 1.1
- Accepted by the GNA-G Automation Working Group
- New version to follow soon with additional terms about **AI** and **Maturity Model**

OAV Common Terms

**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**

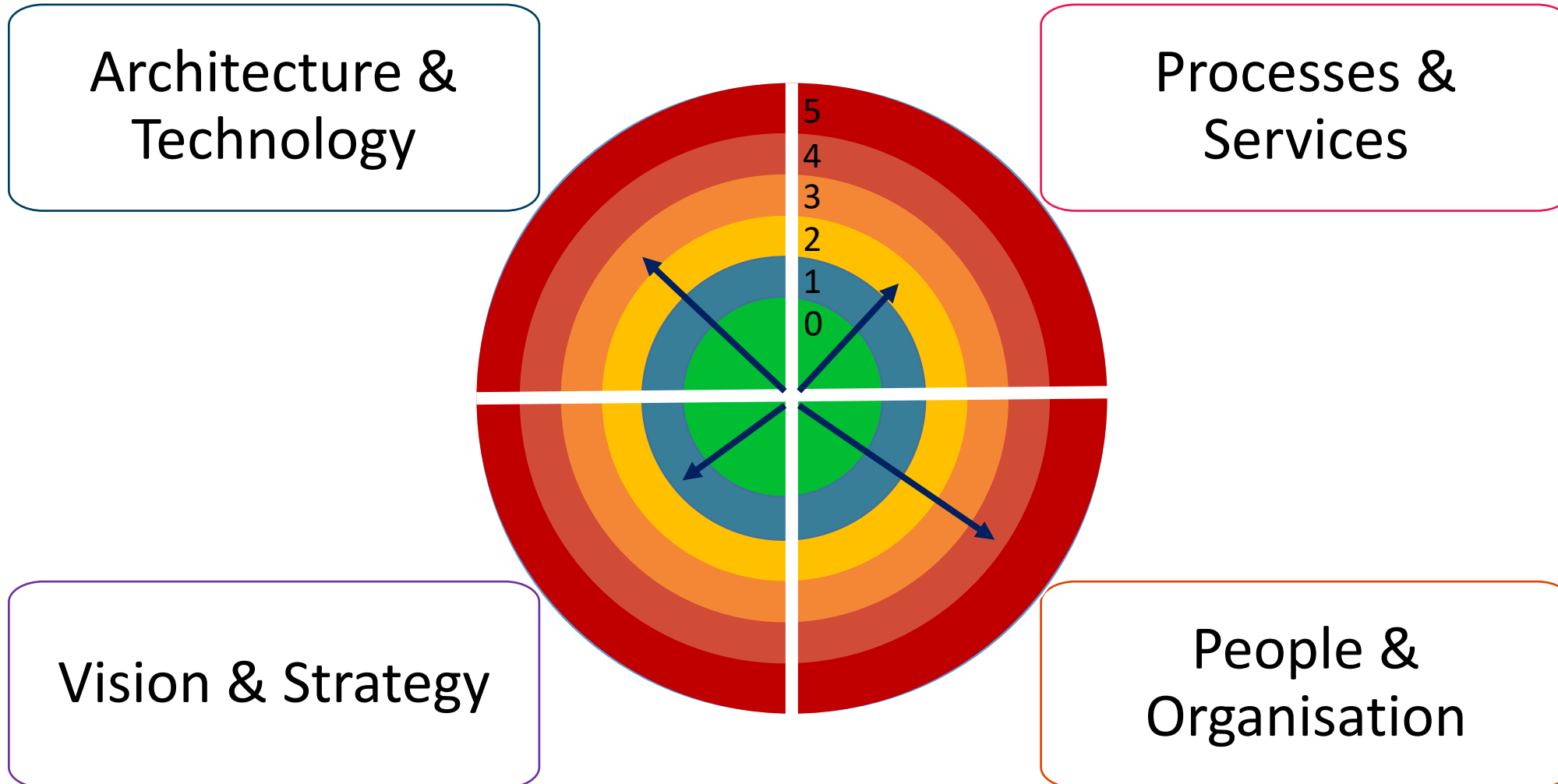
OAV Terms	Definition and reference
Architecture component	<p><i>An architecture component is a nontrivial, nearly independent, and replaceable part of a system that is well-defined architecture.</i></p> <ul style="list-style-type: none"> <li>• TM Forum Reference, TMF071 ODA Terminology, TMF071, Release 19.0.1, October 2019</li> </ul>
Architecture principles	<p><i>Architecture principles define the underlying general rules and guidelines for the use and deployment of an organisation. They reflect a level of consensus among the various elements of the enterprise, and for the decisions.</i></p> <ul style="list-style-type: none"> <li>• based on <a href="https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap29.html">https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap29.html</a></li> </ul>



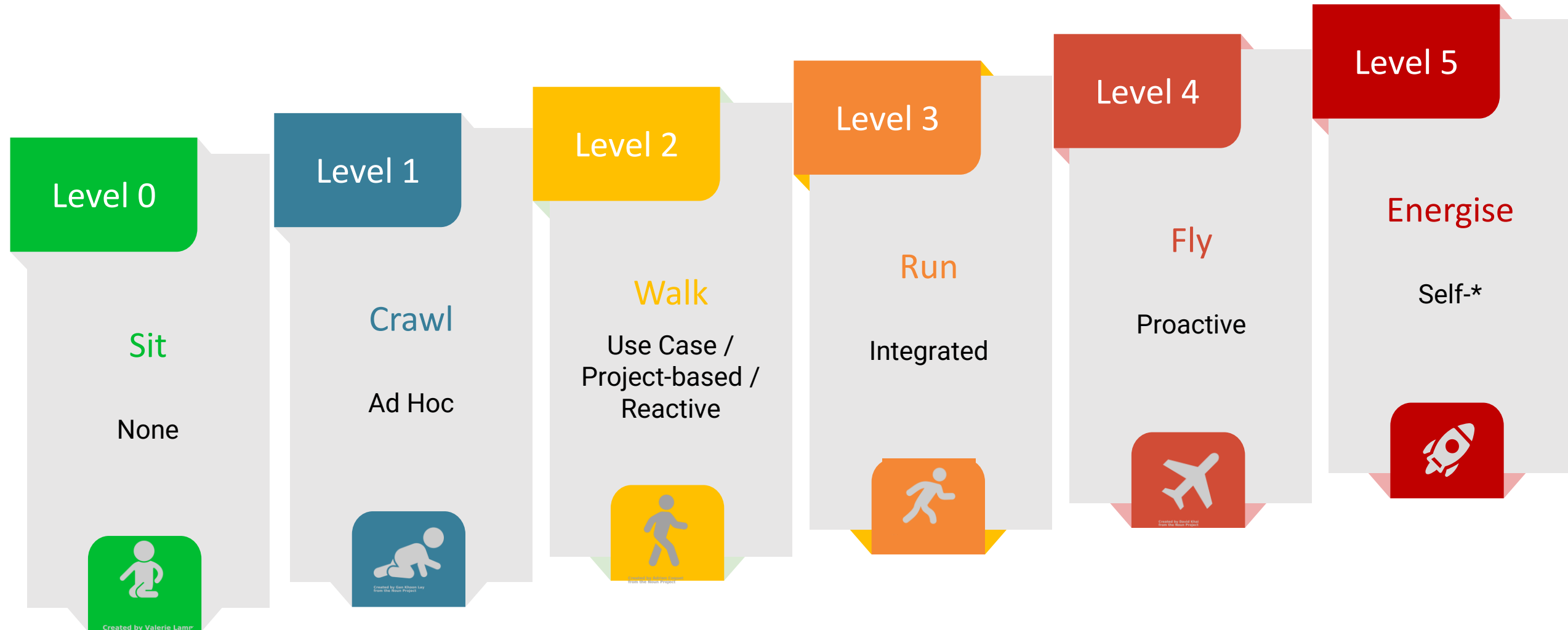
## OAV Maturity Model

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



# OAV Maturity Model - Stages





## The 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 will be used for analytical purposes only (we will not publish data for individual institutions)  
The report will be sent to person defined in survey

# 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>• Hindrik Buining, David Jericho, 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.app.box.com/s/68pzsqbkbcc9683j8qybgoi5zlu7jhtz">https://geant.app.box.com/s/68pzsqbkbcc9683j8qybgoi5zlu7jhtz</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 Regvart, Lidija Jakovčić, Silvije Milišić, 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.app.box.com/s/fji5tdbv2dhtfed137k7mj806mml16">https://geant.app.box.com/s/fji5tdbv2dhtfed137k7mj806mml16</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.ac.cy/">http://www.cynet.ac.cy/</a></li> <li>• <a href="https://www.geant.org/Resources/Documents/GN4-3_White-Paper_CYNET_OAV_Architecture_Analysis.pdf">whitepaper: CYNET OAV Architecture Analysis</a>, <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>• Iacovos 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=1571047057236&amp;api=v2">https://wiki.geant.org/download/attachments/131629403/Funet%20Kampus%20Service.pdf?version=1&amp;modificationDate=1571047057236&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>GÉANT</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 GÉANT, 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>																									

# What Next?

Network Automation eAcademy → Network eAcademy

# With Many Thanks to our Trainers!

Jasone Astorga (RedIRIS / UPV/EHU)	Hamzeh Khalili (RedIRIS / i2CAT)
Estela Carmona (RedIRIS / i2CAT)	Roman Łapacz (PSNC)
Dónal Cunningham (HEAnet)	Anastas Mishev (MARNET / UKIM)
Yuri Demchenko (SURFnet / UvA)	Susanne Naegele-Jackson (DFN / FAU)
Aleksandra Dedinec (MARNET/UKIM)	Simone Spinelli (GÉANT)
Sonja Filiposka (MARNET / UKIM)	Kostas Stamos (GRNET / CTI)
Maria Isabel Gandia (RedIRIS / CSUC)	Your name here?
Eduardo Jacob (RedIRIS / UPV/EHU)	
Iacovos Ioannou (CyNet)	



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

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

# Thank you

With special thanks to the trainers,  
the GLAD and the Comms teams!

Any questions?

Find us here:

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

[www.geant.org](http://www.geant.org)

