



# Network Development in the GÉANT Project

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Public (PU)



GÉANT is the collaboration of European National Research and Education Networks (NRENs) on delivering an information ecosystem of infrastructure and services to advance research, education and innovation on a global scale

# GÉANT Project

Through a long-standing and highly collaborative relationship with the European Union, NRENs and GÉANT provide a stable and innovative environment for research, education, and innovation

Current project generation: GN5-1

500 contributors from 37 R&E partners

50 million users

9 projects



Project Management

Marcoms, Events and Policy Management

User and Stakeholder Engagement

Above-the-net services

Trust and Identity Services Evolution and Delivery

Network Development

Network Core Infrastructure and Core Service Evolution and Operations

Security

Operations support  
GÉANT

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# Topics



# Network Development

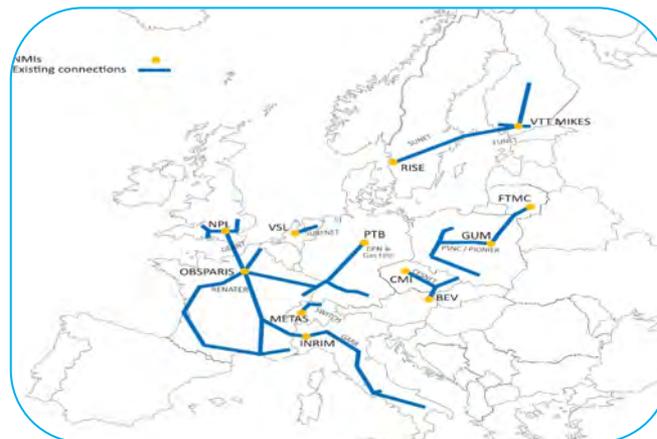
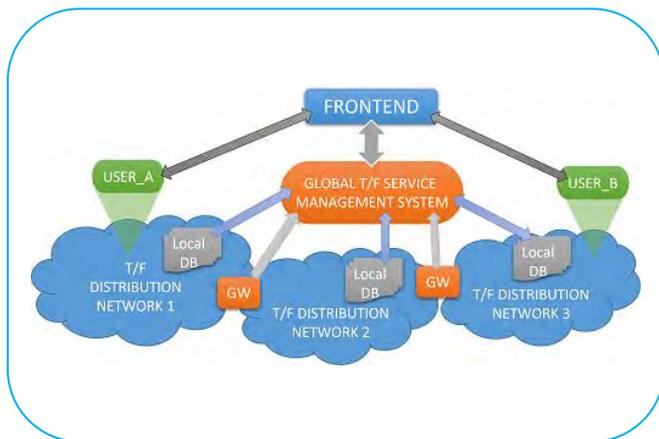
- Optical Time and Frequency Networks - OTFN
- Quantum Technologies - QT
- Router for Academia, Research and Education - RARE
- GÉANT P4 Lab - GP4L

# Optical Time and Frequency Networks - OTFN

Preparing for the forthcoming redefinition of the SI second

Exploring approaches for Time and Frequency (T&F) Services in NREN Networks:

- Building upon already existing T&F infrastructure and services
- T&F Gateway - national signal sources and cross-border transfer
- Monitoring and calibration solutions



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

# Optical Time and Frequency Networks - OTFN

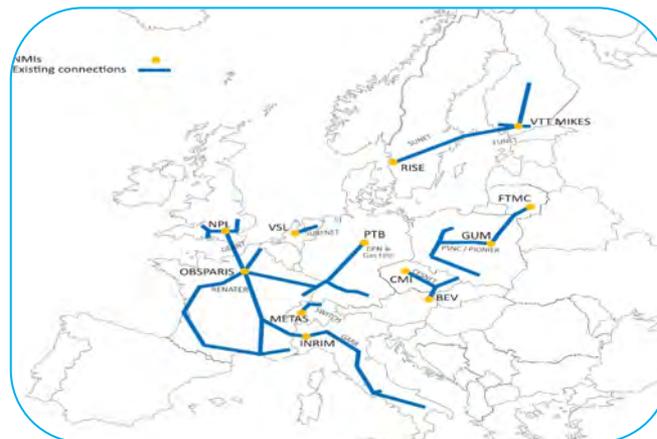
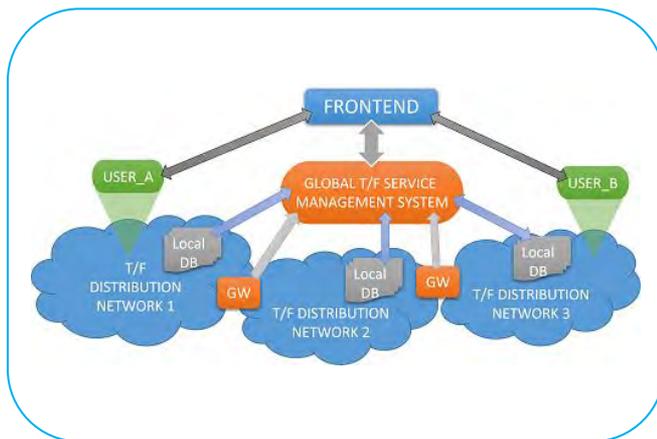
Preparing for the forthcoming redefinition of the SI second

Exploring approaches for Time and Frequency (T&F) Services in NREN Networks:

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New

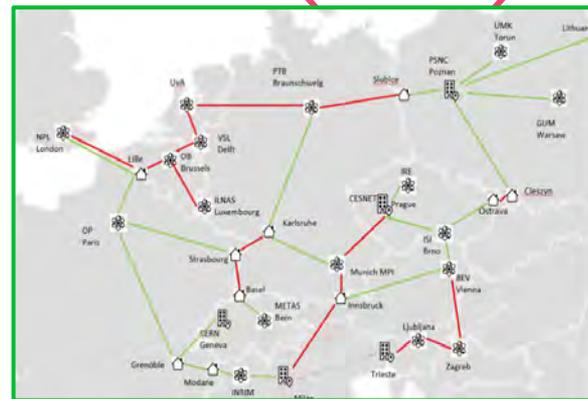
Network  
eAcademy  
OTFN track



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

# Design of the Core Time and Frequency Network (C-TFN)

C-TFN  
Options



C-TFN PathFinder Link



More information in the [GÉANT Core Time/Frequency Network \(GÉANT C-TFN\) Network Development Incubator Report](#)



# RARE - Router for Academia, Research and Education

## An open source router OS for R&E use cases

### Supports six data planes:

- based on UNIX socket
- Libpcap
- DPDK
- BMv2 (P4)
- INTEL TOFINO ASIC (P4)
- XDP, eXpress Data Path

### RARE features (not limited to):

- Interior Routing Protocol
- Dataplane forwarding
- External Routing Protocol
- Link local protocol
- Network management



### RARE

[rare-users@lists.geant.org](mailto:rare-users@lists.geant.org)

[rare-dev@lists.geant.org](mailto:rare-dev@lists.geant.org)

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

### Complete feature list

Type	Test #	Name				
acl	01*	copp	✓	✓	✓	✗
acl	02*	ingress access list	✓	✓	✓	✗
acl	03*	egress access list	✓	✓	✓	✗
acl	04*	nat	✓	✓	✓	✗
acl	05*	vlan ingress access list	✓	✓	✓	✗
acl	06*	vlan egress access list	✓	✓	✓	✗
acl	07*	bundle ingress access list	✓	✓	✓	✗
acl	08*	bundle egress access list	✓	✓	✓	✗
acl	09*	bundle vlan ingress access list	✓	✓	✓	✗
acl	10*	bundle vlan egress access list	✓	✓	✓	✗
acl	11*	bridge ingress access list	✓	✓	✓	✗
acl	12*	bridge egress access list	✓	✓	✓	✗
acl	13*	vlan bridge ingress access list	✓	✓	✓	✗
acl	14*	vlan bridge egress access list	✓	✓	✓	✗
acl	15*	ingress pppoe access list	✓	✓	✓	✗
acl	16*	egress pppoe access list	✓	✓	✓	✗
acl	17*	ingress vlan pppoe access list	✓	✓	✓	✗
acl	18*	egress vlan pppoe access list	✓	✓	✓	✗
acl	19*	hairpin ingress access list	✓	✓	✓	✗
acl	20*	hairpin egress access list	✓	✓	✓	✗
acl	21*	hairpin vlan ingress access list	✓	✓	✓	✗
acl	22*	hairpin vlan egress access list	✓	✓	✓	✗
acl	23*	hairpin pppoe ingress access list	✓	✓	✓	✗
acl	24*	hairpin pppoe egress access list	✓	✓	✓	✗
acl	25*	hairpin vlan pppoe ingress access list	✓	✓	✓	✗
acl	26*	hairpin vlan pppoe egress access list	✓	✓	✓	✗
acl	27*	ingress gre access list	✓	✓	✓	✗
acl	28*	egress gre access list	✓	✓	✓	✗
acl	29*	ingress vlan gre access list	✓	✓	✓	✗

# GP4L - GÉANT P4 Lab

**P4 switch-based** lab infrastructure interconnected through the GÉANT network

- 8 switches in Europe: AMS, POZ, FRA, BUD and GNV (4)

**Validation of the RARE/FreeRtr OS routing stack software**

World-wide testbed, offering **experimental dataplane programming facilities to researchers** to perform geographically distributed network experiments:

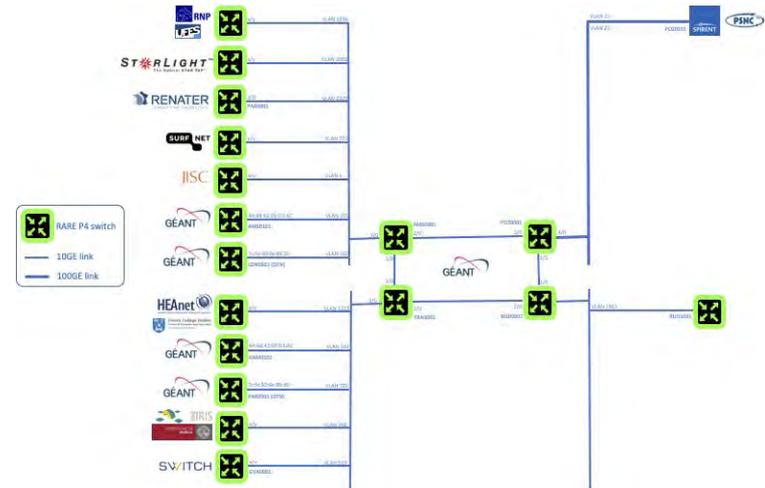
- With the usage of RARE/FreeRtr NOS
- Using a clean slate environment (i.e without RARE/FreeRtr dataplane & control plane)

A platform for **advancing network operations**:

- New device management
- New experiment reservation
- Digital Twin

Managed and supported using NMaas as a platform

## GP4L GÉANT P4 LAB



# Global P4 Lab



Over **30** locations worldwide

Strong collaboration with the **Data Intensive Science** and **AutoGOLE/SENSE GNA-G** Working Groups

# Production Services and Software

- NMaaS
- perfSONAR
- Performance Management Platform - PMP
- WiFiMon
- TimeMap
- Argus
- Network eAcademy

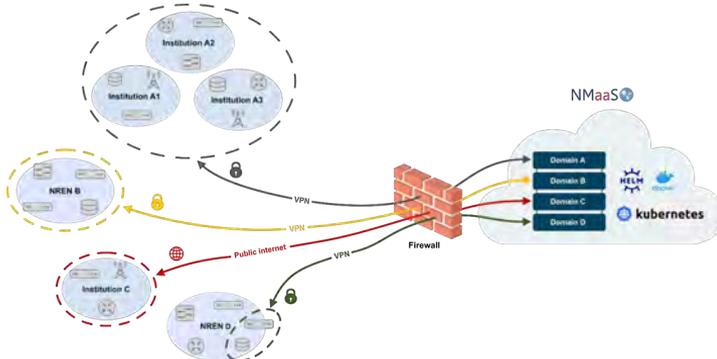
# NMaaS - Network Management as a Service



A portfolio of network management applications run as dedicated, cloud-based per-user instance

## Management of small and medium size networks

- 37 Net management applications available
- Stable, reliable and secure
- Tenants isolation by VPNs, firewall and network configuration
- Simple, efficient procedure for onboarding users
- Technical support of the NMaaS team



## Use cases

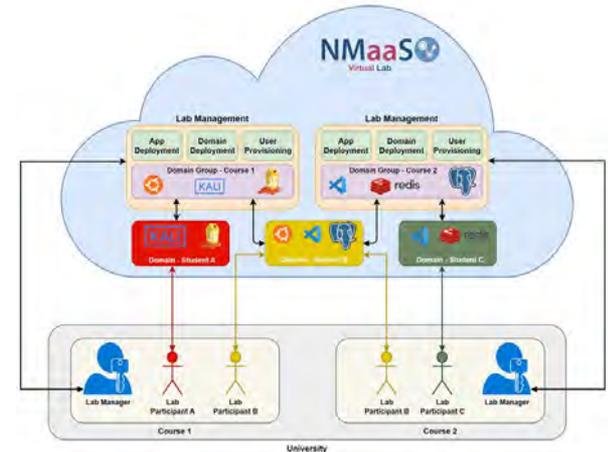
## Virtual Labs for universities and hands-on educational exercises

- Application deployment in the cloud
- No application configuration overhead
- Simple access and management for Lab Managers and Participants

2 Pilot courses

- IT service management
- Network Security

@Ss. Cyril and Methodius University in Skopje, North Macedonia



# How to use NMaaS?

## Managed service

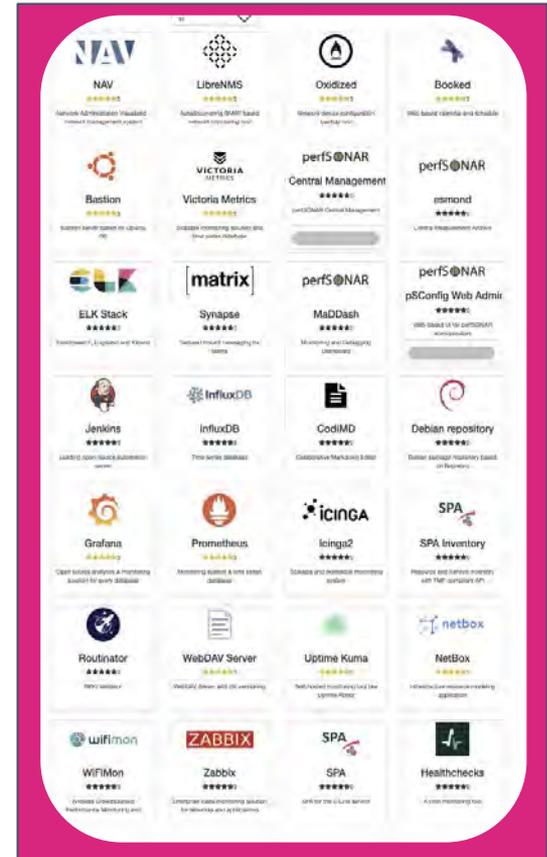
- Production NMaaS instance: <https://nmaas.eu>
- Sandbox instance: <https://nmaas.geant.org>

## Self-hosted

- On your own NMaaS instance: <https://docs.nmaas.eu/install-guide>
- On a local machine: <https://docs.nmaas.eu/local-vm>

**nmaas.eu**

**nmaas@lists.geant.org**



# MaaS



The Single Source of Truth for network automation!

Resource Inventory and Service Inventory implemented as a stand-alone application

- Storage for the information about resources and service instances
- Use of NoSQL (MongoDB) database
- Data model can be easily updated/ extended and validated
- In use in GP4L
- In testing in PSNC/PIONIER
- Available on NMaaS

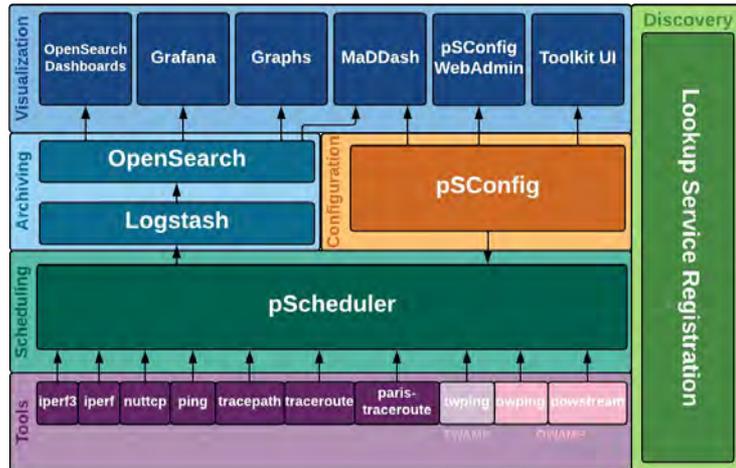


# perfSONAR

Open-source, modular, flexible architecture for IPv4 and IPv6 active network measurement and monitoring

## Some GÉANT's recent contributions:

- Lookup Service dashboards
- Microdep integration with perfSONAR
- On-demand perfSONAR Graphical User Interface (psGUI)



Over 2000 registered hosts in more than 1000 organisations around the world

# Performance Measurement Platform - PMP

## Exploring the performance of the GÉANT backbone while experiencing perfSONAR on small nodes

- Low-cost hardware nodes with pre-installed perfSONAR software and deployed in GÉANT collaborating organisations in Europe and Africa.
- Central components including a central Measurement Archive (MA) and a Dashboard.
- Measurement points in the GÉANT backbone network
- PMP data analysis for new service report using AI/ML
- In green: Countries with the PMP service coverage in Europe

**Dashboard:** <https://pmp-central.geant.org/maddash-webui/>

**Contact:** [perfsonar-smallnodes@lists.geant.org](mailto:perfsonar-smallnodes@lists.geant.org)



# TimeMap

Per-segment latency and jitter monitoring tool

Based on TWAMP (RFC 5357)

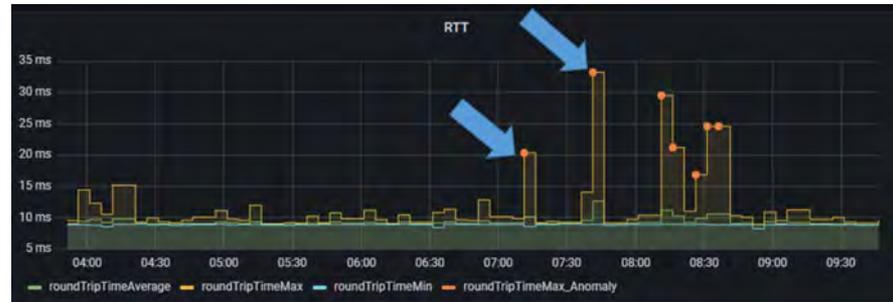
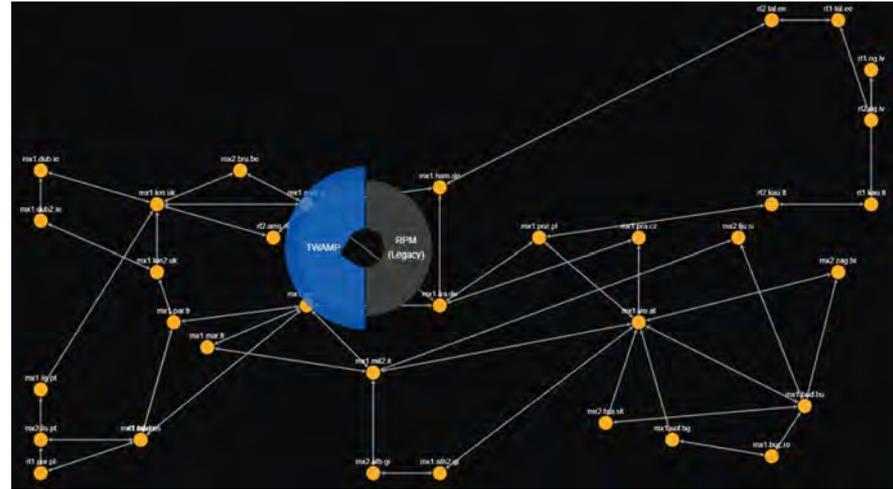
Easy and quick modular installation

Initial AI-based anomaly detection implemented

Deployed in the [GÉANT backbone network](#)

## Documentation

- [TimeMap](#)
- [Code and documentation](#)
- [TimeMap page](#)





## An alarm aggregation and correlation tool

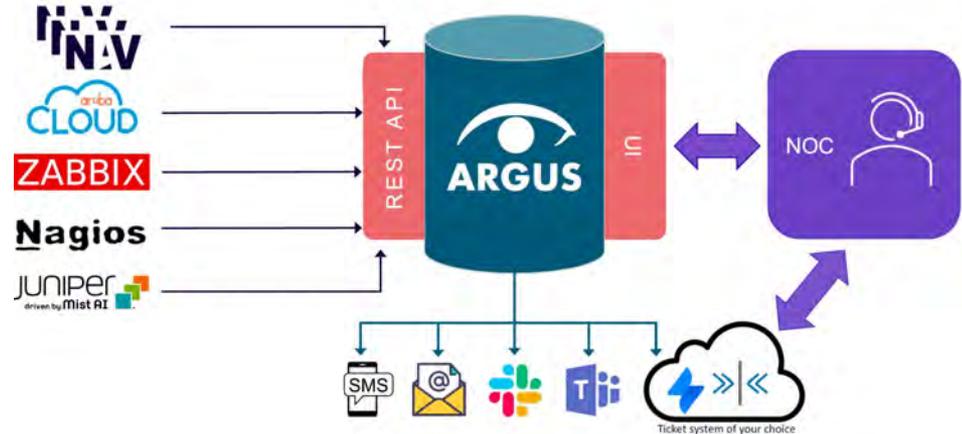
- A single unified dashboard and notification system for aggregated incidents from all monitoring applications
- Based on the CNaas use case
- In production in Sikt and SUNET
- A production service since Sept 2022

<https://wiki.geant.org/display/netdev/argus>

The screenshot shows the ARGUS web interface with a table of incidents. The table has the following columns: Timestamp, Status, Severity level, Source, Description, and Actions. The incidents listed are:

Timestamp	Status	Severity level	Source	Description	Actions
2022-04-28 09:56	Open	Warning	foo.customer1.example.org	box down example-ws.customer1 192.168.42.42	[Icon]
2022-04-27 11:42	Open	Warning	mobility.missile.example.org	AP down: AP1553 at somecollege	[Icon]
2022-04-02 13:12	Open	Critical	bar.customer1.example.org	box down main-pgw.customer1 192.168.0.1	[Icon]
2022-04-02 09:32	Open	Warning	bar.somecritical.example.org	bar device: no3g3cncr-ds1_somedrop sensors:bar-1_2_2_preDncCurrentLatePower exceeded at :37.32<0.34	[Icon]
2022-04-02 08:32	Open	Info	zabbix.example.org	alarm.example.org: Software RAID: Device mso is active.degraded	[Icon]

At the bottom of the interface, it says: "Last refreshed 2022-05-03 15:38:50 updating every 30" and "Backend v1.5.1.dev1+g18f8a05 API v1(stable), frontend v1.5.4".



# WiFiMon

## A WiFi network monitoring and performance verification system

**WiFiMon** is a WiFi network monitoring and performance verification system. It is capable of detecting performance issues, visualising the achievable throughput of a wireless network for each user, and providing technical information about a WiFi network (e.g., signal strength, link quality, bit rate, etc.). **WiFiMon** leverages well-known performance verification tools (e.g., Akamai **Boomerang** and **Speedtest**) and in addition uses data from the WiFi physical layer in order to gather a comprehensive set of WiFi network performance metrics.

### WiFiMon Operation Modes

*WiFiMon can operate in two different modes which can be used either separately or together*

#### Software Crowdsourced Measurements



#### Hardware Probe Measurements



[WiFiMon](#)



# wifimon

### Technology and vendor agnostic



**WiFiMon** can be deployed on any WiFi network as it monitors the performance on the network layer. It can also provide additional benefits in 802.1x enabled networks including **eduroam** in which case users can make various performance analyses per access point, per user, etc.

### Fine grained information on network performance



**WiFiMon** shows the end-user (mobile client) behaviour on a network, its perception about the responsiveness of the network and the speed of web resource downloads, correlation of the performance data with end-user data, and data analysis with an effective query builder.

### Easy to deploy



**WiFiMon** is a software image (also available as a Docker Image) and can be easily deployed on an NREN/University network on hardware or software probes.

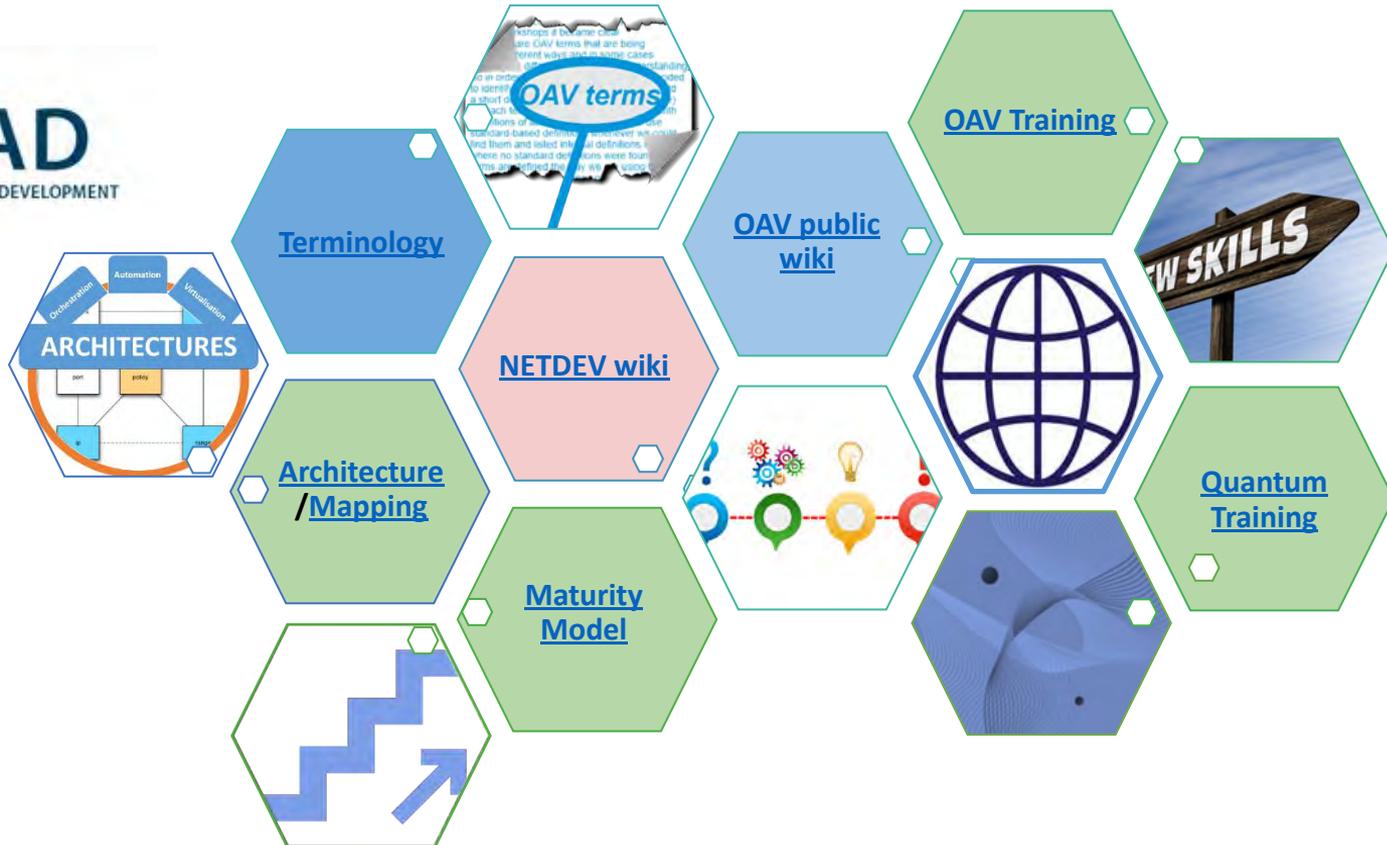
### Active monitoring with low network overhead



**WiFiMon** active measurements are not significantly invasive and do not use any significant bandwidth. One **WiFiMon** measurement is comparable to one average web-page download (load speed).

# Network eAcademy

Powered by:



## Network eAcademy Learning Tracks

**Orchestration,  
Automation and  
Virtualisation**

**Quantum Technologies**

**Optical Time and  
Frequency Networks**

**Artificial Intelligence**

**...to be continued**

# Network Automation eAcademy

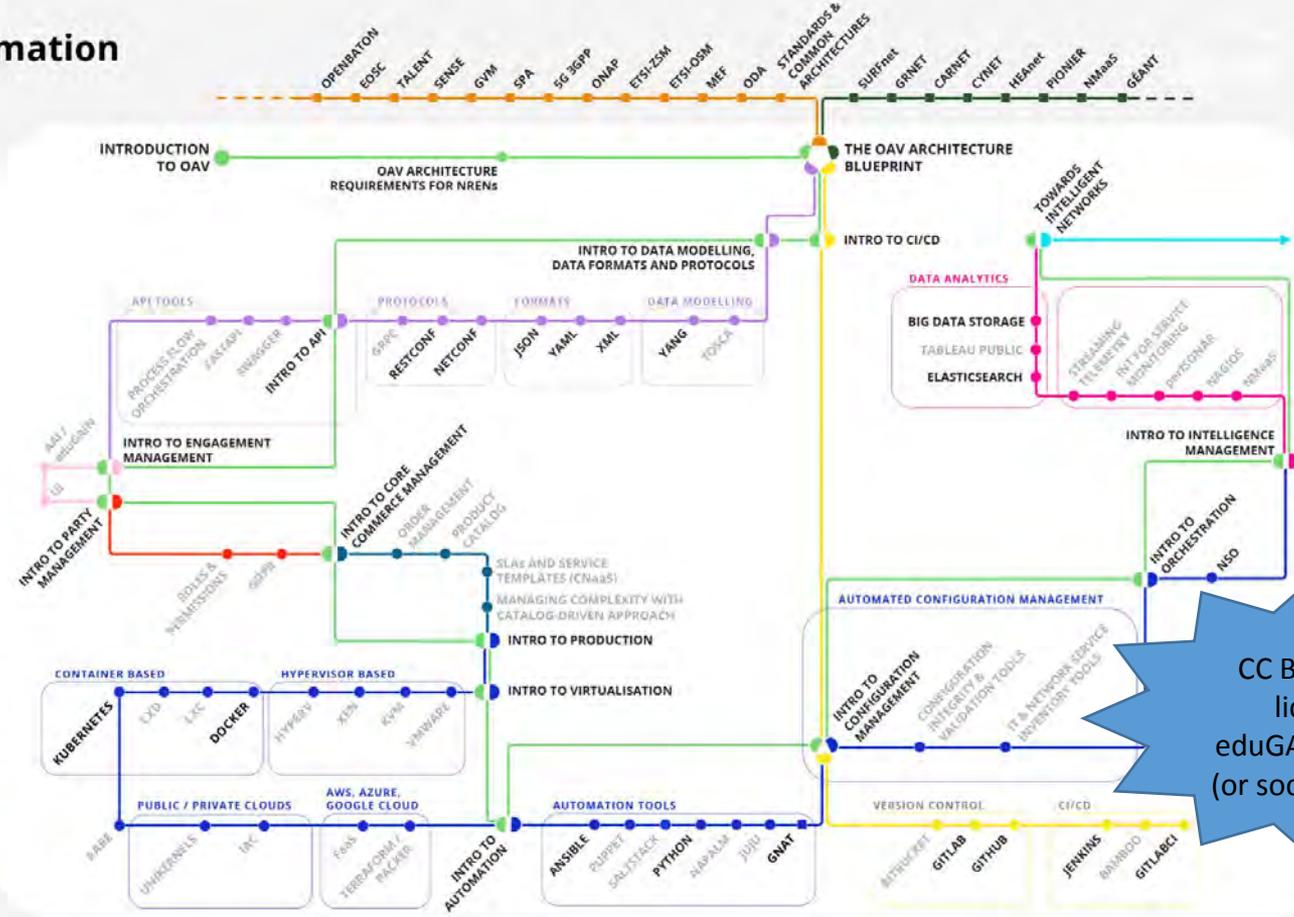
**Legend**

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

**Tracks**

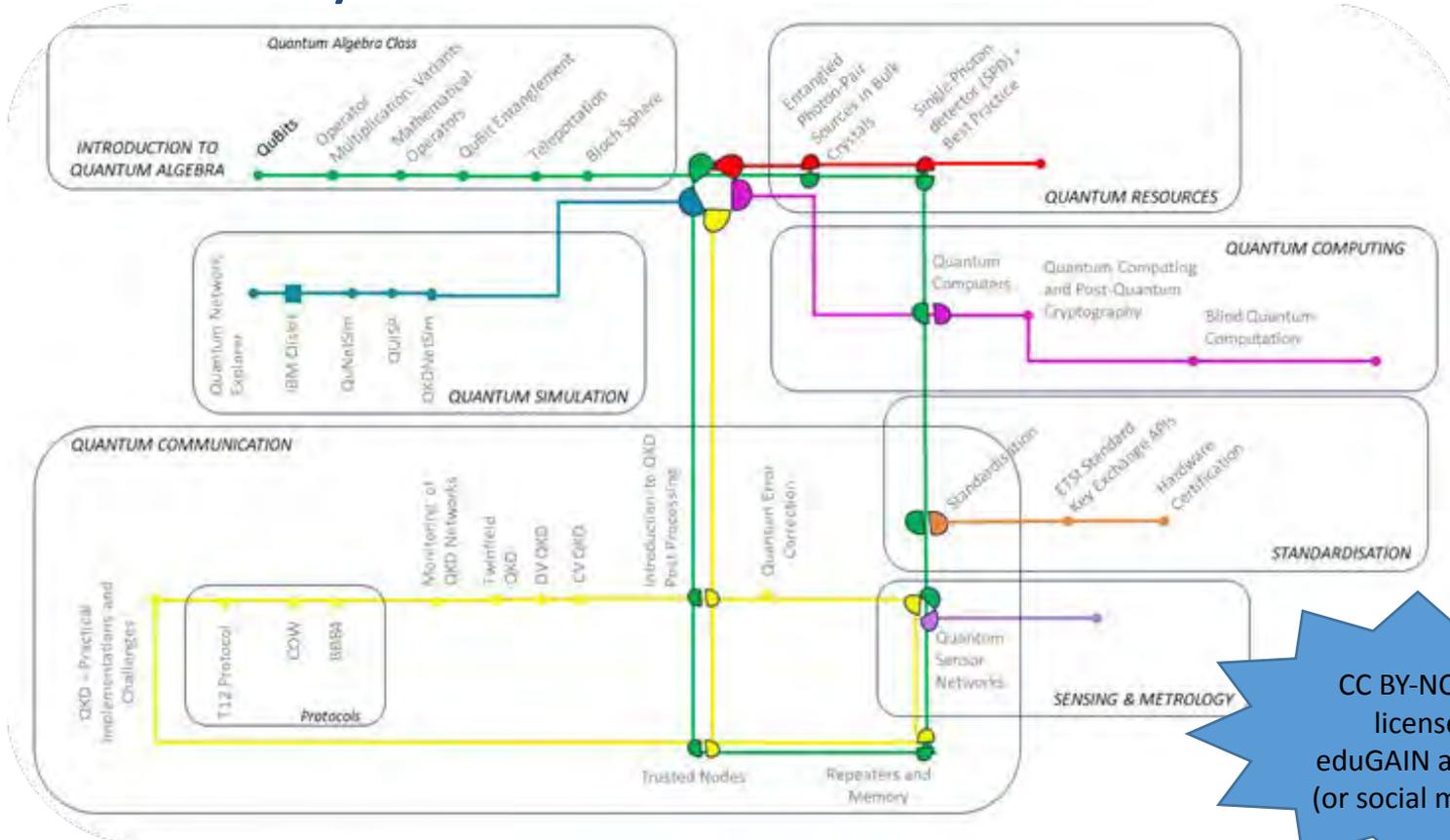
- GENERAL INTRODUCTION
- AGILE, DevOps, CI/CD
- DECOUPLING & INTEGRATION
- PRODUCTION
- ENGAGEMENT MANAGEMENT
- PARTY MANAGEMENT
- CORE COMMERCE MANAGEMENT
- INTELLIGENCE MANAGEMENT
- OAV REALISATION
- USE CASES AND EXAMPLES
- ARCHITECTURE

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



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license  
eduGAIN access  
(or social media)

# Quantum eAcademy



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## OAV Terminology

Terminology and Glossary of terms related to:

- Orchestration, Automation and Virtualisation
- Maturity Model
- Artificial Intelligence

Motivation:

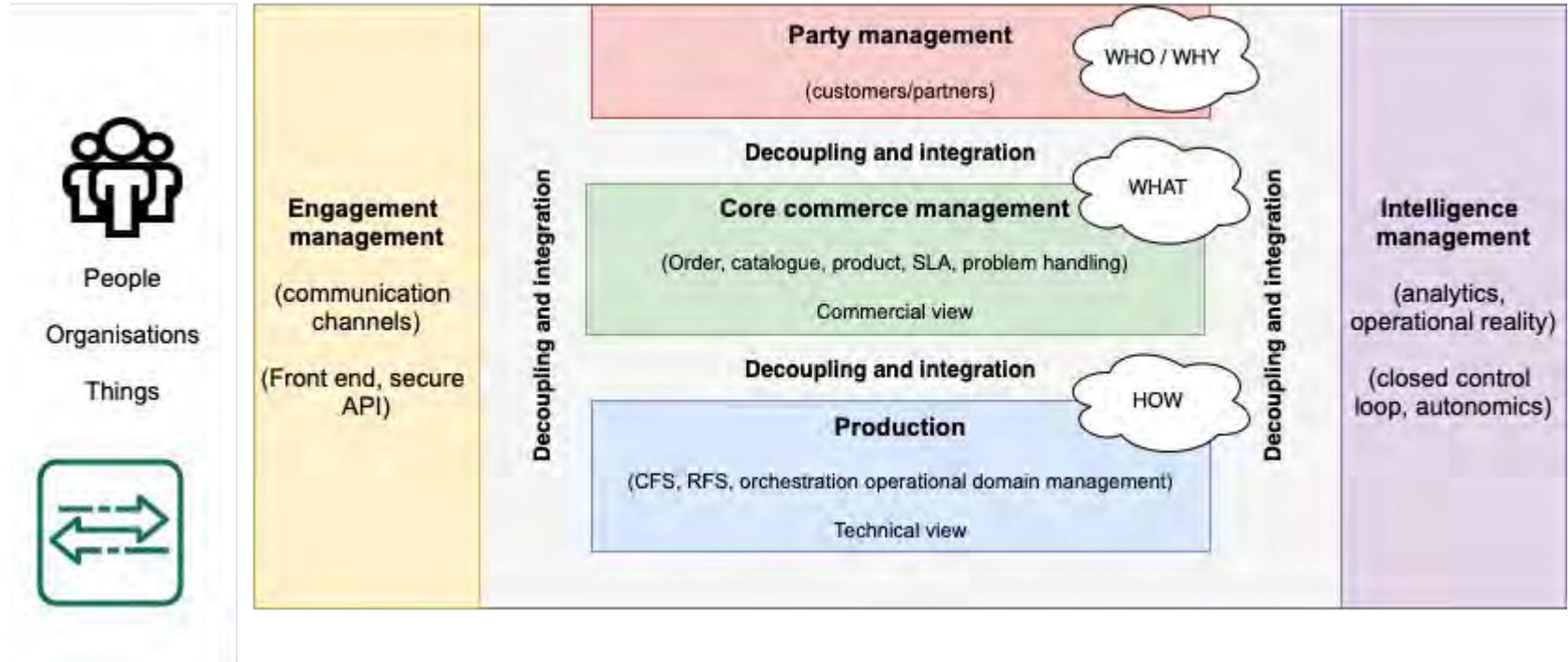
- To bridge the terminology gap in the community
- To systematically structure relevant OAV, AI and MM terminology

Published in collaboration with the GNA-G Automation Working Group

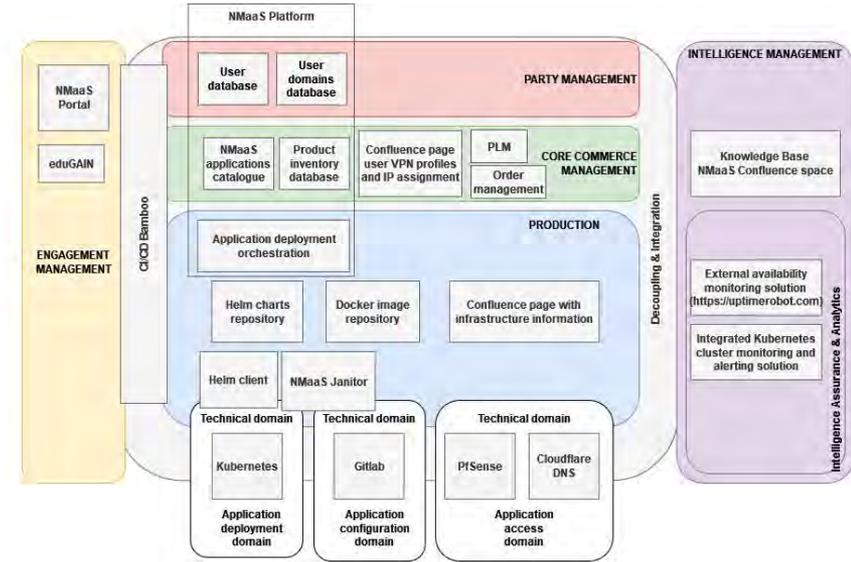
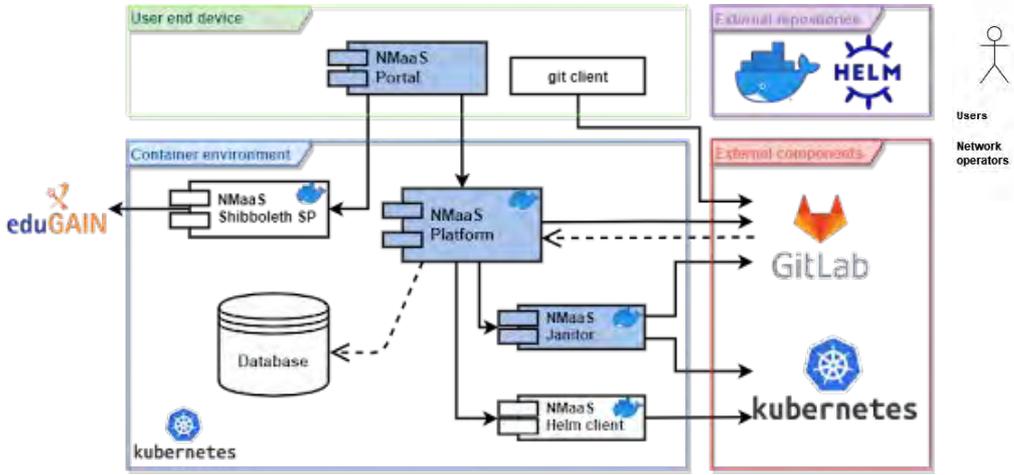


[OAV Terminology Document](#)

# TMForum Open Digital Architecture as a Reference Architecture



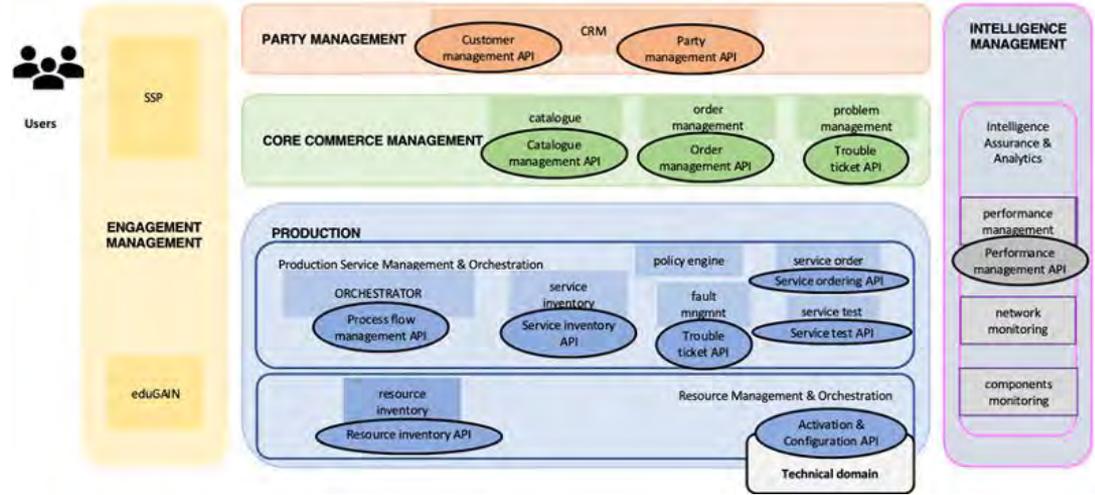
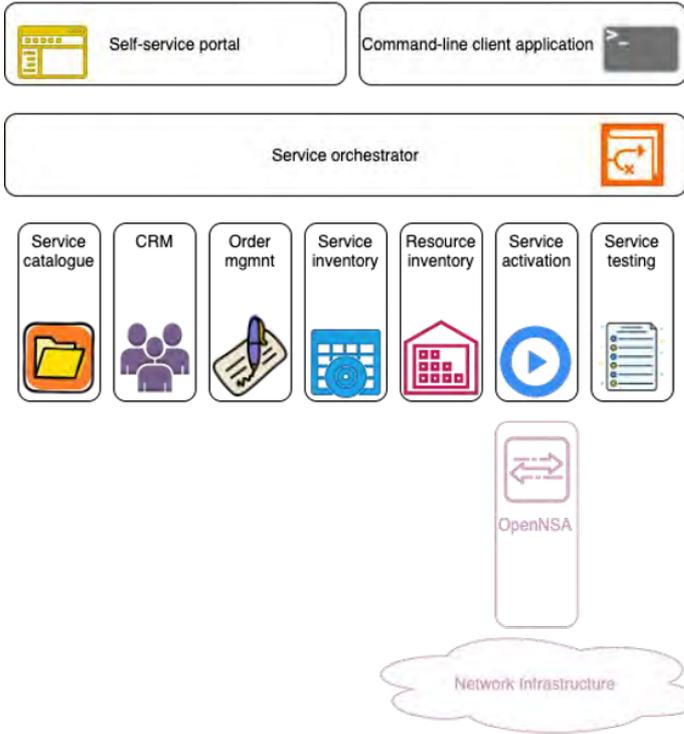
# NMaaS Architecture



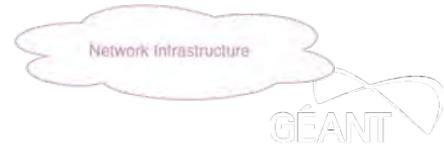
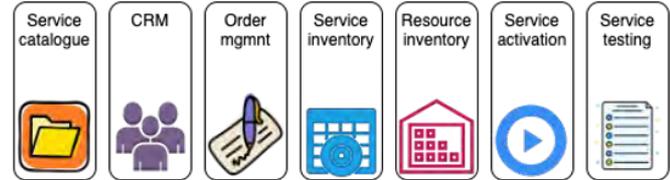
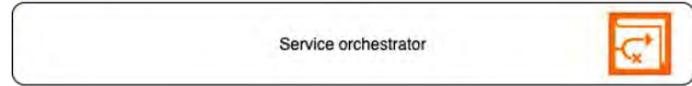
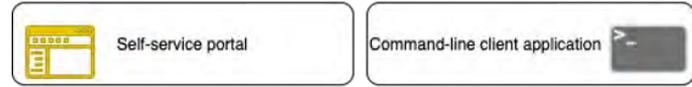
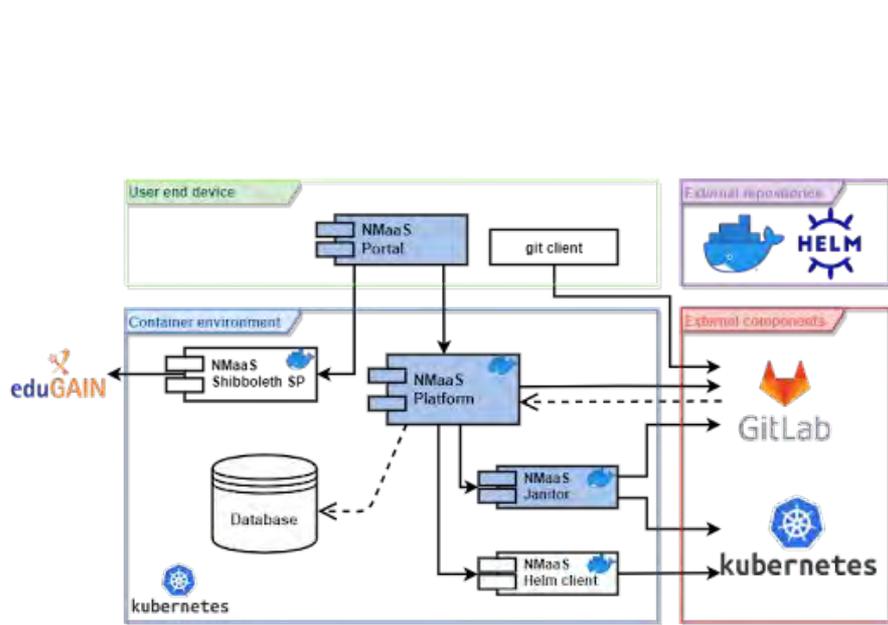
[NMaaS-OAV-Architecture-Analysis](#)



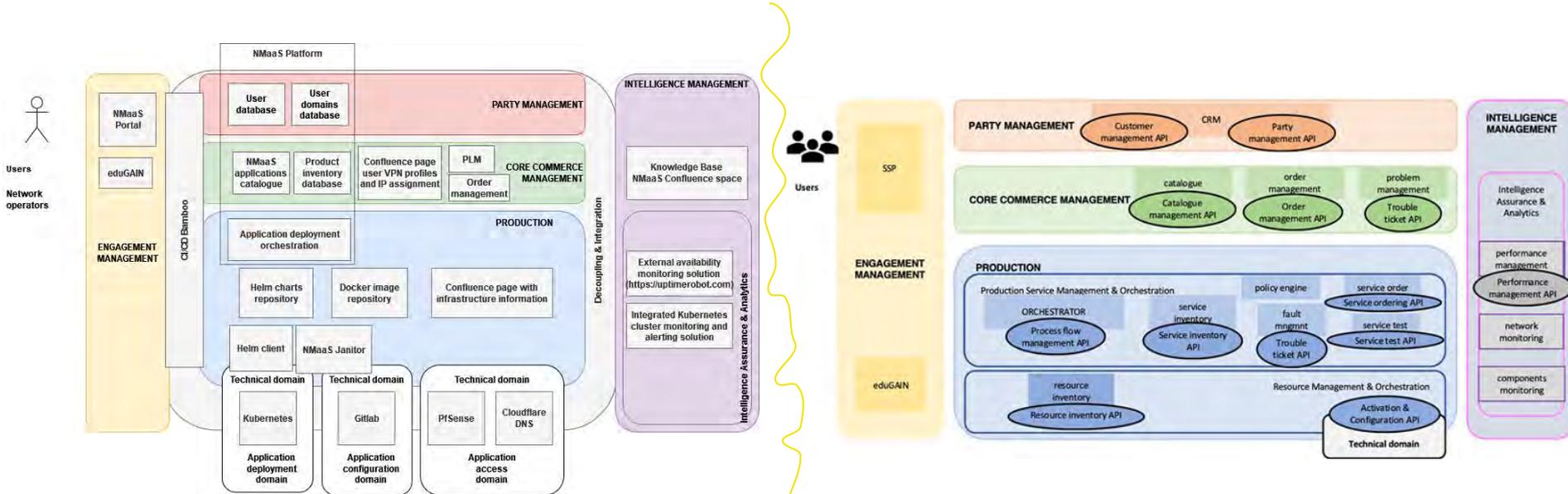
# Service Provider Architecture



# NMaaS and SPA Architectures



# NMaaS and SPA Architectures



# Digital Architecture Analysis

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



## NREN Architectures

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

## NETDEV Architectures

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

## Other Use Cases

- [5G](#)
- [EOSC](#)
- [ETSI GANA](#)
- [ETSI OSM](#)
- [ETSI ZSM](#)
- [GVM](#)
- [MEF LSO](#)
- [Open Baton](#)
- [ONAP](#)
- [SENSE](#)
- [TALENT](#)

# Maturity Model for Orchestration, Automation and Virtualisation (OAV)

## A self-assessment tool as a digital transformation progress indicator:

- 31 questions
- Data is used for analytical purposes only
- Report is sent to the person defined in survey
- Individual responses not published



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

## NETDEV Incubator

A mechanism to include new work during the project  
Simple proposal procedure following simple rules

A proposed project MUST be:

- Relevant to the NETDEV project (GN5-1 WP6)
- SMART: *Specific, Measurable, Achievable, Resource- and Time-bound*
- With evident interest for the results from the community

Incubator projects so far:

- Optical Time and Frequency Networks
- Fibre Sensing
- Workflow Orchestrator Telemetry Module

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



# Collaboration

- Special Interest Groups - SIG-NOC
- Global Network Advancement Group - GNA-G
- Global Research Platform
- MetrANOVA

## GÉANT SIGs

**GÉANT Special Interest Groups - SIGs** are established under the auspices of GÉANT in order to create an

**open forum**

where experts from its community **exchange information, knowledge, ideas and best practices**

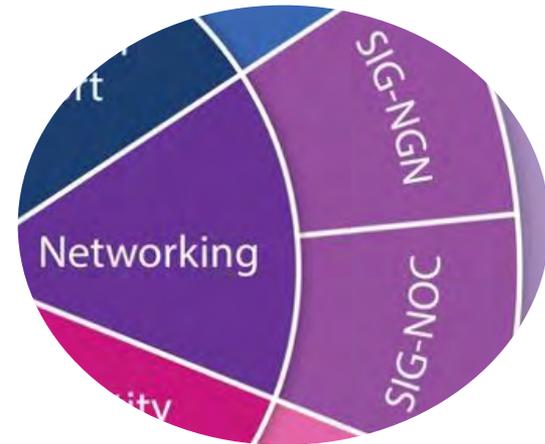
about specific **technical or other areas** of business relevant to the research and education networking community.



# GÉANT SIGs - Network

## 2 Network-related SIGs:

- Network Operations Centre - [SIG-NOC](#)
- Next Generation Networks - [SIG-NGN](#)



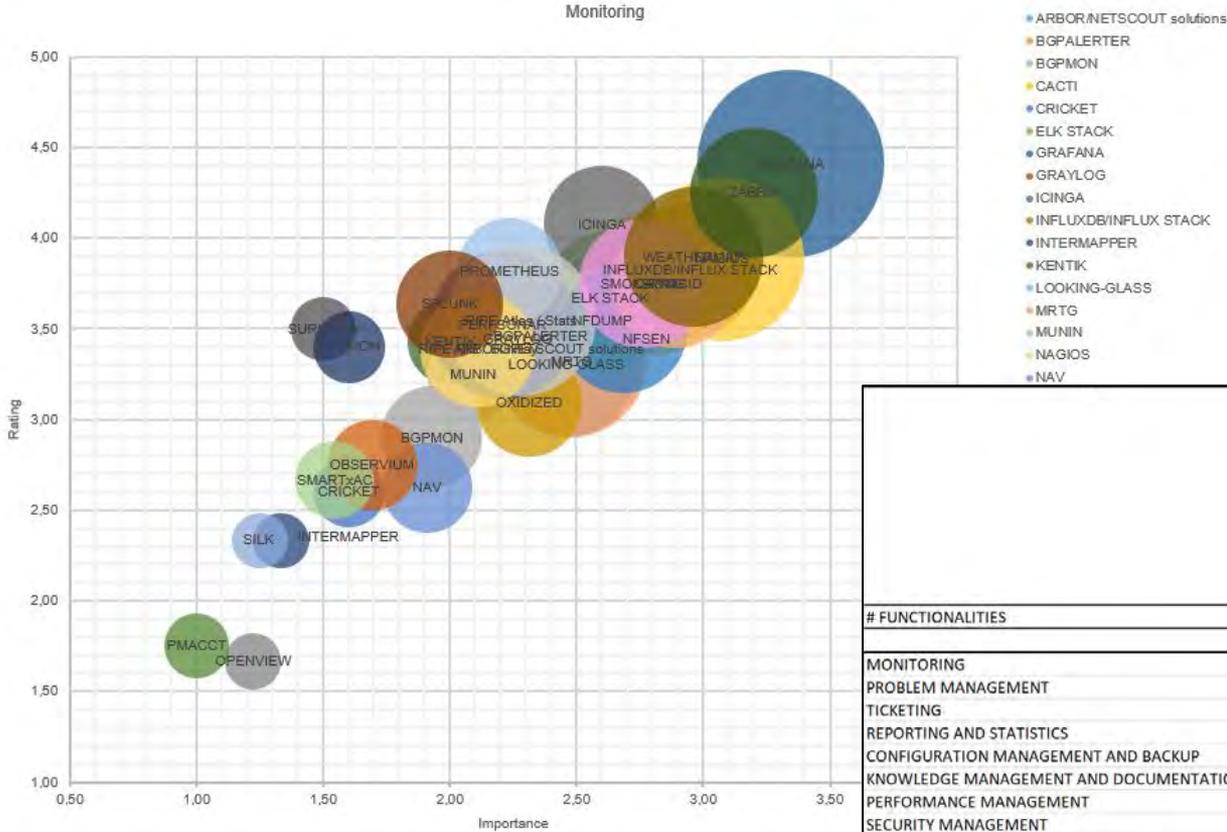
## SIG-NOC Tools Survey - Report and Matrix

Covers 16 NOC functions

- Monitoring
- Problem Management
- Ticketing
- Reporting and Statistics
- Configuration Management and Backup
- Knowledge Management and Documentation
- Performance Management
- Security Management
- Inventory Management
- Communication, Coordination and Chat
- Out-of-band Access Management
- Resources Management
- Change Management
- DDoS Mitigation
- Data Aggregation, Representation, Visualisation
- Orchestration, Automation and Virtualisation



# SIG-NOC Tools Survey: Report and Matrix

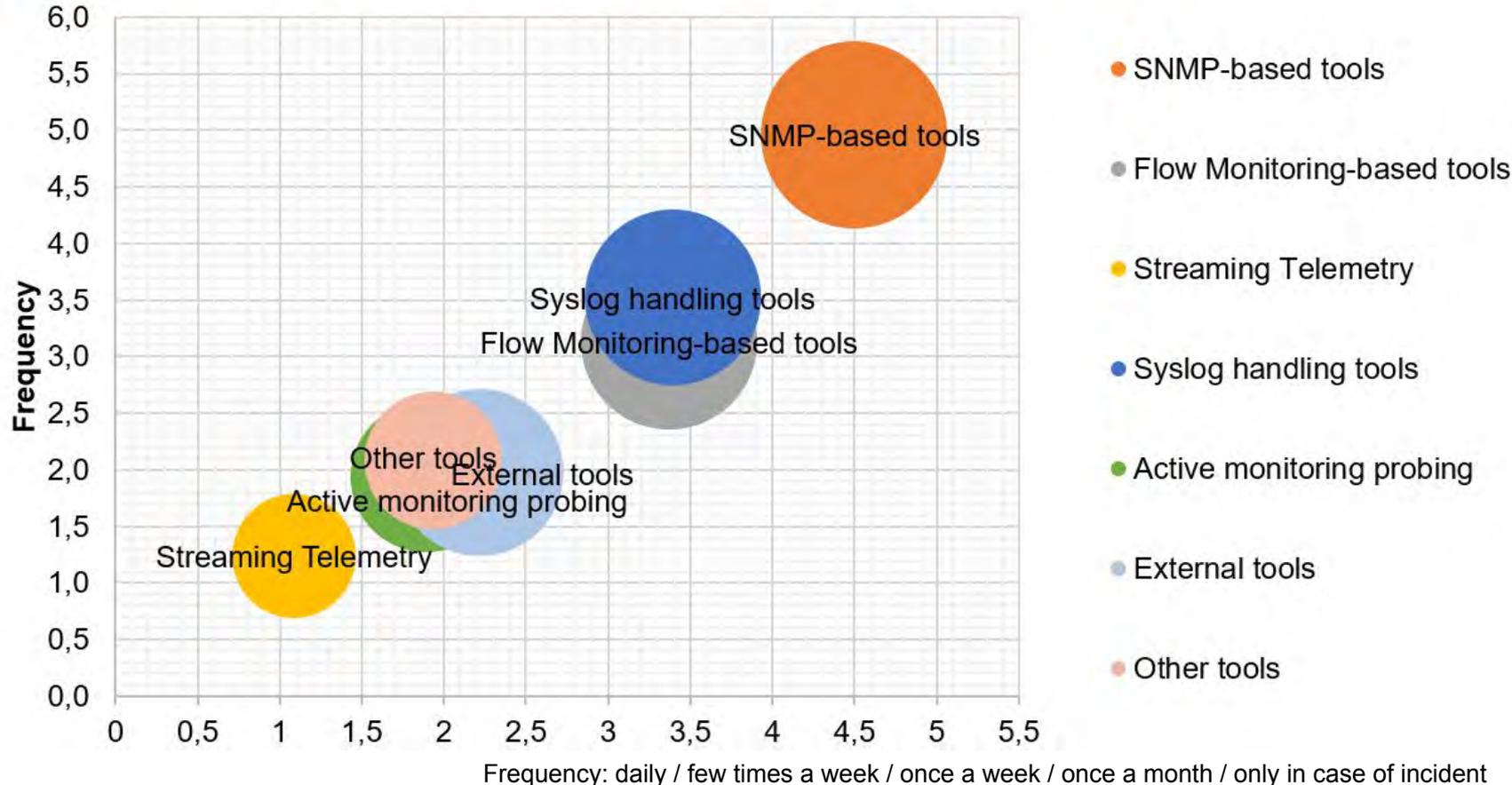


	ANSIBLE	ARBOR (REMEDY)	ADJUM	BGP FLOWSPEC	BGP MON	BOX	BWCTL	CA SPECTRUM	CACTI
# FUNCTIONALITIES	1	3	1	1	2	1	1	1	3
MONITORING		17			20				30
PROBLEM MANAGEMENT									
TICKETING			3						
REPORTING AND STATISTICS		10						4	21
CONFIGURATION MANAGEMENT AND BACKUP							3		
KNOWLEDGE MANAGEMENT AND DOCUMENTATION									
PERFORMANCE MANAGEMENT								8	
SECURITY MANAGEMENT					10				
INVENTORY MANAGEMENT									
COMMUNICATION, COORDINATION AND CHAT									

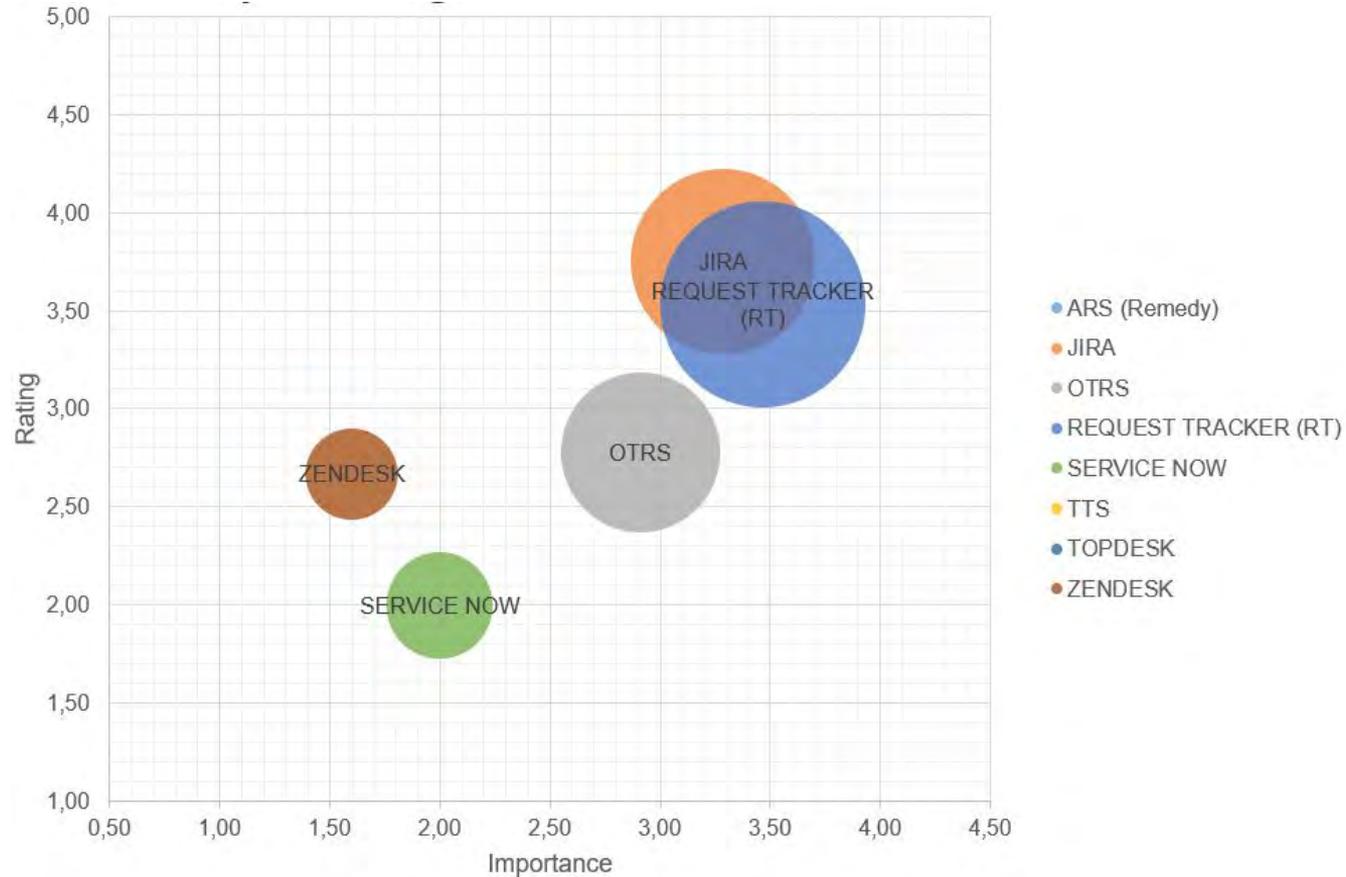
**SIG-NOC**

- Academic and Research Network of Slovenia (ARNES)
- CAR
- CELLS - ALBA Synchrotron
- CSUC
- CYNET
- DFN
- EHU/IUPV
- FT/JFCN
- GEANT
- GRENA
- GRNET
- IIAP NAS RA (ASNET-AM)
- itacyl
- Pompeu Fabra University (UPF)
- RedIRIS
- RENAM
- RNP
- SUNET

# SIG-NOC Tools Survey: Monitoring Tools per Methodology



## SIG-NOC Tools Survey: Ticketing Tools



## SIG-NOC Tools survey:

- On average, each institution uses 11,5 tools for monitoring.
- Mix of open-source / vendor-based and distributed tools.
- Even if there are many specific tools for resource or inventory management, spreadsheets are commonly used.
- You can find the report, the matrix and the results here:

<https://wiki.geant.org/display/SIGNOC/SIG-NOC+Tools+Survey+2023>



## 20th SIG-NOC meeting - Helsinki, Finland

7&8 May 2024

[Register](#)  
To join us in Helsinki!

# Going Global

- GNA-G - Global Network Advancement Group
- Global Research Platform



## GNA-G = Global Network Advancement Group

A community of network professionals from the R&E networking organisations worldwide



### The GNA-G goal

Work together to better align resources and make the continent-to-continent interconnections more efficient for global science collaborations and transnational education

### The GNA-G Vision

The international collaboration of national R&E networks on more effective use of resources and interconnection of R&E networks for science and future development of these networks

### The GNA-G Mission

Ensure the technologies, infrastructures and investments of the partners and participants are utilised for interconnecting R&E networks on a global scale.

## GNA-G Modus Operandi

- The work is taking place within Working Groups
  - Regular meetings - weekly, bi-weekly, monthly
  - Work per objectives and expected outcomes
- Working groups
  - Proposed through a charter
  - Established and closed by the Leadership Team
- Community meetings
  - Working group results report
  - Presentations on a specific topic from several organisations / regions
- Each community meeting organised in two sessions, e.g.:
  - 6am - 8am UTC, suits Asia, Australia, New Zealand, Africa, and Europe
  - 8pm - 10pm UTC, suits North America, Latin America, Africa, and Europe

**Communicate, Contribute, Collaborate**

## GNA-G Working Groups

### Established:

- AutoGOLE/SENSE
- Data Intensive Science
- GREN Map
- Network Automation
- GNA-G Routing WG
- GREN Engineering Advancement
- Security Bootcamps
- NomCom - Nomination Committee

### Next meetings:

Q2 Community VC, tbd

[@TNC24](#), 10.6.2024

GNA-G Network Automation WG Meeting, 09:00 - 12:30

GNA-G Community Meeting, 14:00 - 17:30

More info: <https://www.gna-g.net/meeting/>



David Wilde, Chair  
AARNet (Australia)



Harvey Newman  
Caltech (USA)



Buseung Cho  
KISTI (South Korea)



Ivana Golub  
PSNC (Croatia/Poland)



Marco Teixeira  
RedCLARA (Latin America)



Alex Moura  
KAUST (Saudi Arabia)



## GRP = The Global Research Platform

An international scientific collaboration led by:

The International Center for Advanced Internet Research (iCAIR) at Northwestern University,

The Electronic Visualization Laboratory (EVL) at the University of Illinois Chicago,

The Qualcomm Institute–Calit2 at UC San Diego,

and

its partners worldwide.



<https://www.theglobalresearchplatform.net/>

## GRP = The Global Research Platform Objectives

- Create one-of-a-kind **advanced** ubiquitous **services** that **integrate resources around the globe** at speeds of gigabits and terabits per second.
- Focus on design, implementation, and operation strategies for
  - Next-generation distributed services and infrastructure
  - High-performance data gathering, analytics, transport, computing, and storage, at 100 Gbps or higher.
- Global partnering for distributed cyberinfrastructure to support data-intensive scientific workflows

<https://www.theglobalresearchplatform.net/>



Source. Avatar

## GRP Meetings and Topics

Often collocated with some other event (IEEE, SC, SCA...)

### Topics:

- Large-Scale Global Science
- Next-Generation Research Platforms
- Orchestration Among Multiple Domains
- Large-Scale Data WAN Transport
- High-Fidelity Data Flow Monitoring
- Visualization, Analytics, Diagnostic Algorithms,
- Event Correlation AI/ML/DL

## The Global Research Platform

The **4th Global Research Platform Workshop (4GRP)** will take place October 9-10, 2023 in Limassol, Cyprus, co-located with the **19th IEEE International Conference on e-Science**. 4GRP and eScience attendees share common interests, content and culture. Co-location provides 4GRP and eScience attendees with the option to register for both events. **The 4GRP website is under construction.**



# MetrANOVA

A Consortium for Advancing Network Observation, Visualization and Analysis

New Consortium MetrANOVA to Create a Measurement and Analysis Toolbox for Research and Education Networks Worldwide

Please fill in the [MetrANOVA Survey](#)



## Forthcoming Events

### March

- 21 March, [WiFiMon InfoShare](#), online

### April

- 18 April, [OAV Architecture Workshop](#) (Brussels, Belgium)

### May

- 7-8 May, [20th SIG-NOC Meeting](#) (Helsinki, Finland)
- 14-16 May, [4th European perfSONAR User Workshop](#) (Trondheim, Norway)

### June

- 10-14 June, [TNC24](#) (Rennes, France)
  - NETDEV, perfSONAR, RARE, nmaas, GP4L,
  - GNA-G, MetrANOVA
  - ... and more



# Thank You!

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