Network Technologies and Services Development in the GÉANT Project

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RIPE85

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Belgrade, Serbia

www.geant.org

Network Technologies and Services Development in the GÉANT Project

- GÉANT project environment
- Network Technologies and Services Development
  - Production Services
  - Production-ready Services
  - Research and Development
  - Completed Work
- Collaboration
- Next steps

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** available to them.

A part of the European Union's Horizon 2020 research and innovation programme - GÉANT 2020 Framework Partnership Agreement (FPA)

500 contributors from 40 partners - European R&E Institutions

50 M users

GN4-3 duration: 1 Jan 2019 – 31 December 2022

The GÉANT Project Structure

WP2 Communications	WP3 Stakeholder engagement	WP4 Online services dev & delivery	WP5 T&I services evolution & dev	WP6 Network technologies & services dev	WP7 Net Core Infr & Core Service Evolution & Ops	WP8 Security	WP9 Operations Support
Task1 Communications Graphic Design	Task1 Partner Relations	Task1 Service delivery: platform	**Task1 T&I Services**	Task1 Net technology evolution	**Task1 Network Engineering & Implementation**	Task1 Business Continuity	**Task1 Operations Centre including CERT**
Task2 Services Marketing	Task2 Research Engagement	Task2 Service delivery: business desk	Task2 T&I Incubator	Task2 Net services evolution & dev	**Task2 Network Evolution & Future Planning**	Task2 Security Baselining	Task2 Software Governance and Support
Task3 Event Management	Task3 Intelligence Gathering	Task3 Service dev: video conferencing	**Task3 T&I Operational Support**	Task3 Monitoring & Management	**Task3 Implementation of the Fibre IRU Project**	Task3 Products and Services	**Task3 Service Management**
	Task4 Community Programme	Task4 Service dev: cloud offerings	Task4 T&I Enabling Communities				**Task4 GEANT Software Development and Operations**
		Task5 Service adoption support					

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WP Leaders: **Tim Chown (Jisc), Ivana Golub (PSNC)**
WP6 budget: > 6,2 mil EUR
33 R&E organisations from 23 countries
88 team members

Network Technologies and Services Development (WP6)

T1: Network Technology Evolution

- TimeMap latency and jitter monitoring tool
- Optical Time and Frequency Networking (OTFN)
- Quantum Key Distribution (QKD)
- In-band Network Telemetry (INT) using Data Plane Programming (DPP)
- Router for Academia, Research and Education (RARE)
- GÉANT P4 Lab
- White box

T2: Network Services Evolution and Development

- Service Provider Architecture Platform (SPA)
- Network Automation eAcademy
  - Orchestration, Automation and Virtualisation (OAV) training
  - Architecture and ODA mapping
  - Wiki with the Community Portal
  - OAV Terminology
  - OAV Maturity Model
- Campus Network Management as a Service (CNaaS)
- Data Transfer Nodes

T3: Monitoring and Management

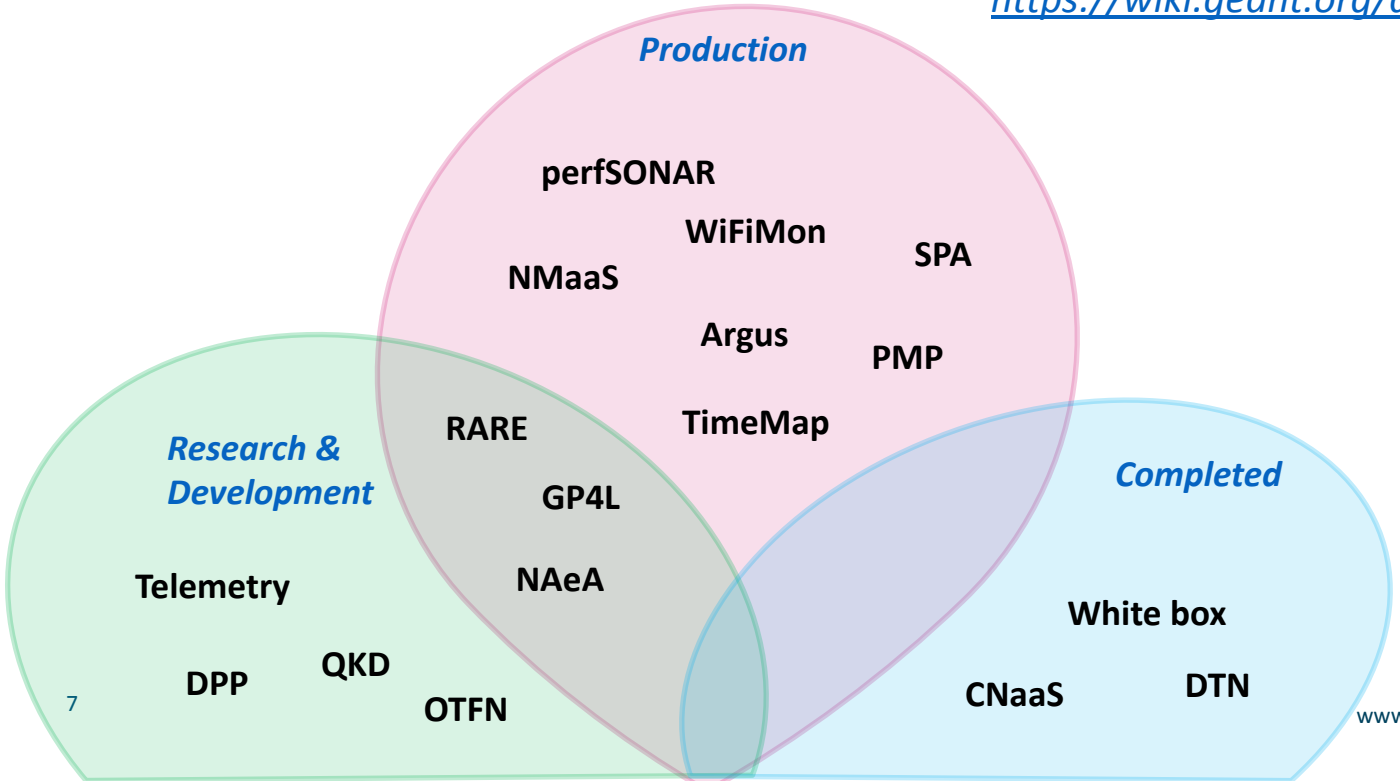
- perfSONAR
- Performance Measurement Platform (PMP)
- Network Management as a Service (NMaaS)
- WiFiMon
- Argus
- Network Telemetry
  - 100G monitoring/measurement
  - P4-based flow monitoring

- Production
- Production-ready
- Research and Development
- Completed

https://wiki.geant.org/display/NETDEV

Network Technologies and Services Development (WP6)

https://wiki.geant.org/display/NETDEV



Production Services

Pass several independent audits:

- ✔ Used in an operational environment
- ✔ Code security and quality checked
- ✔ Intellectual Property Rights checked
- ✔ GDPR checked
- ✔ Service Definition completed
- ✔ Cost Benefit Analysis in place
- ✔ Business development and roadmap defined

NETDEV Production Services:

perfSONAR

Performance Measurement Platform

WiFiMon

NMaaS

TimeMap

SPA Service Provider Architecture

ARGUS

Deploy | Contribute

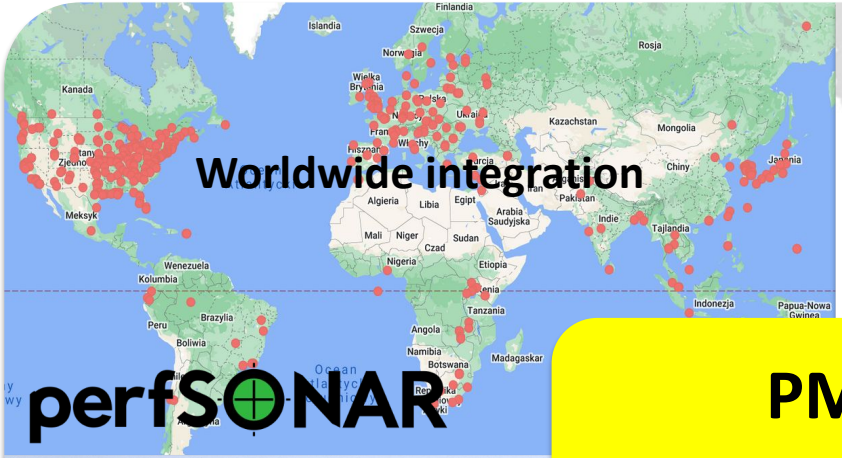
perfSONAR

https://www.perfsonar.net/

- A well established toolkit for active network performance monitoring
- International collaboration with ESnet, GÉANT, IU, I2, RNP, UoM
- Providing consultancy advice and guidance to the GÉANT community
- Latest releases:
  4.4.5 and 5.0.0 Beta 1

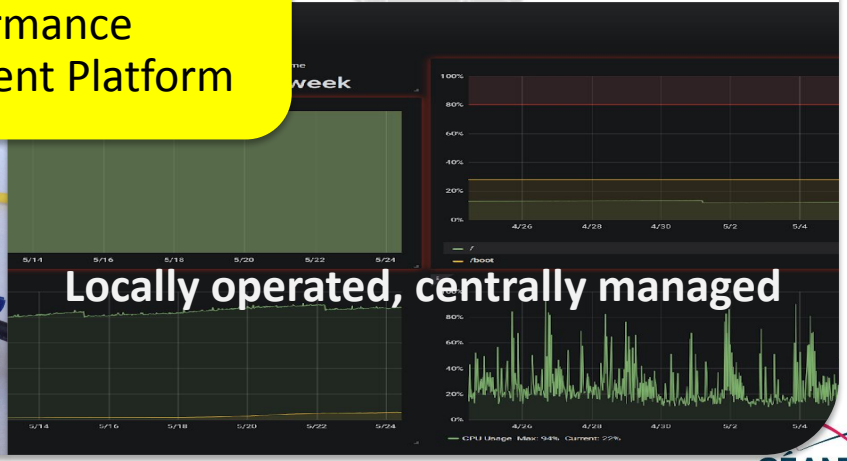
ESnet GÉANT INDIANA UNIVERSITY INTERNET2 RNP ORGANIZAÇÃO SOCIAL DO MCTI UNIVERSITY OF MICHIGAN

GÉANT



PMP

Performance
Measurement Platform



Deploy Collaborate

Performance Measurement Platform (PMP)

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

- Helps troubleshoot network performance issues
- Access to historical data
- Uses worldwide measurement infrastructure
- Access via CLI and GUI
- Uses multiple network metrics
- Strong collaboration with participating organisations

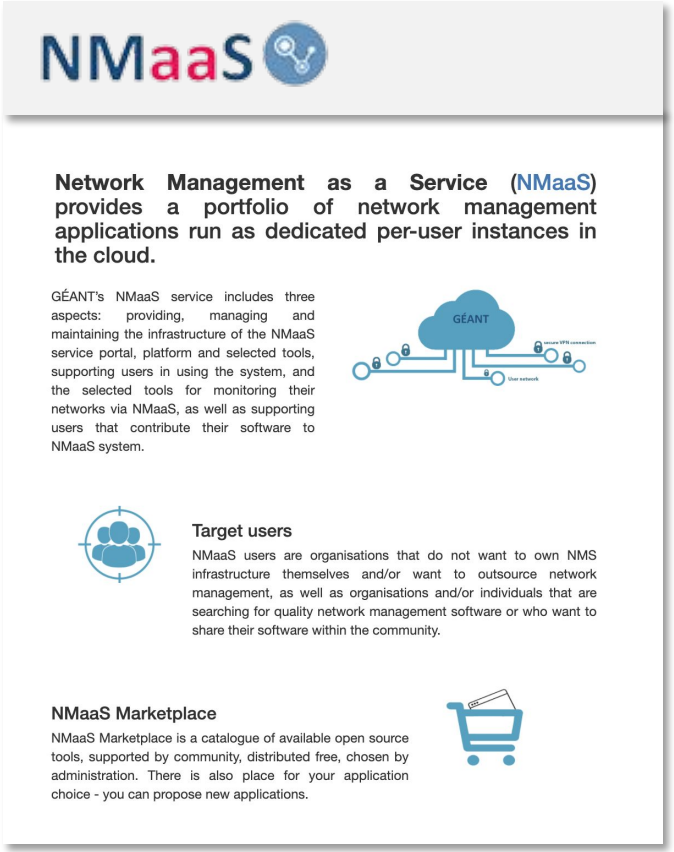
Participate:

- Play and learn
- Run CLI tests from/to nodes
- Extend with more nodes
- Implement your ideas

https://pmp-central.geant.org/maddash-webui/

https://network.geant.org/performance-measurement-platform/

Network Management as a Service (NMaaS)



NMaaS is a platform for network management providing

- A portfolio of network management and monitoring applications
- Per-user, secured network monitoring infrastructure
- Dockerised images implemented through a Kubernetes cluster

NMaaS Usage

- On GÉANT instances or deployed locally
- NMaaS sandbox instance in GÉANT: https://nmaas.geant.org/
- NMaaS production instance in PSNC: https://nmaas.eu/

NMaaS Update

- Version 1.5.1 released
- The work on providing support for IPv6 is ongoing
- NMaaS OAV Architecture Analysis was published

NMaaS

NMaaS Portfolio

28 applications available

including: WiFiMon WAS, SPA Service Inventory, SPA for E-line Service,and perfSONAR components (Central Management, Esmond, pSConfig Web Admin, MaDDash)

NMaaS Usage Statistics

- 150 registered users
- 27 domains
- 113 deployed applications

WiFiMon

A WiFi network monitoring and performance verification system

- Detects performance issues and visualises network workload
- Hardware probes and crowdsourced measurements
- Leverages well-known performance verification tools

WiFiMon Features

- Independence of Wi-Fi technology and hardware vendor
- IPv4 and IPv6 support
- Correlation with RADIUS and DHCP logs respecting user privacy
- WiFiMon Analysis Server (WAS) available on NMaaS
- Current version 1.6.1 with TWAMP measurements on the hardware probe
- Suitable for heterogeneous networks
- **Suitable for eduroam monitoring!**

NMaaS

eduroam

https://wiki.geant.org/display/WIF/

https://www.geant.org/wifimon

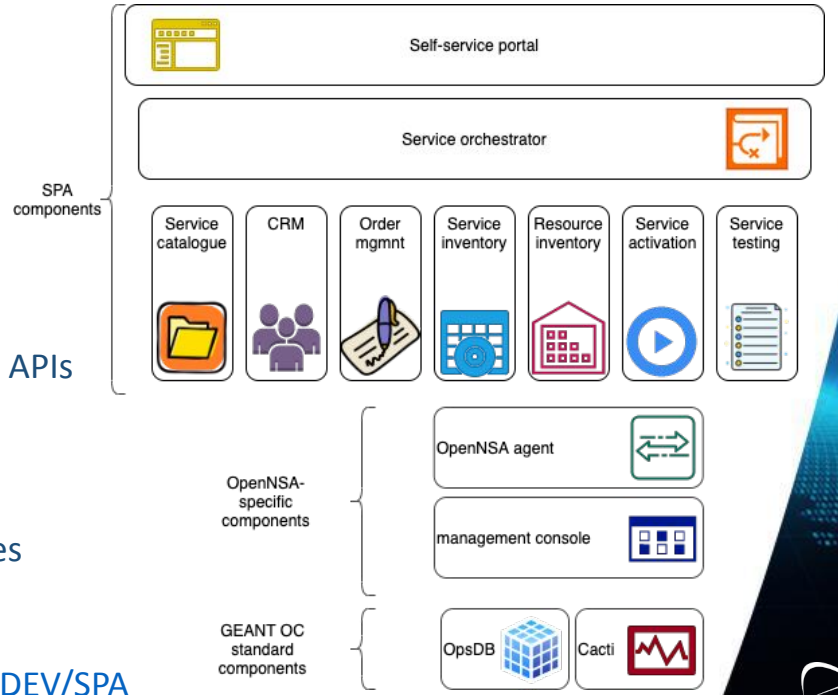
Service Provider Architecture Platform (SPA)

Digital business and service management platform

Provides:

- flexible service management
- fast design of composite services
- component based scalability
- interoperability through widely adopted Open APIs
- TMForum ODA-compliant software tools

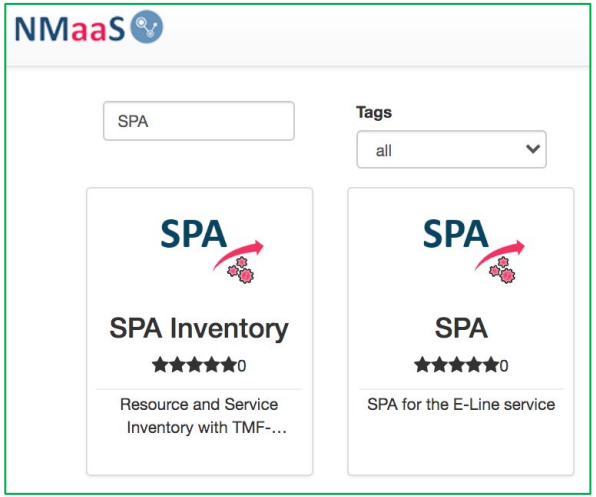
Used in production for GÉANT connectivity services



https://wiki.geant.org/display/NETDEV/SPA

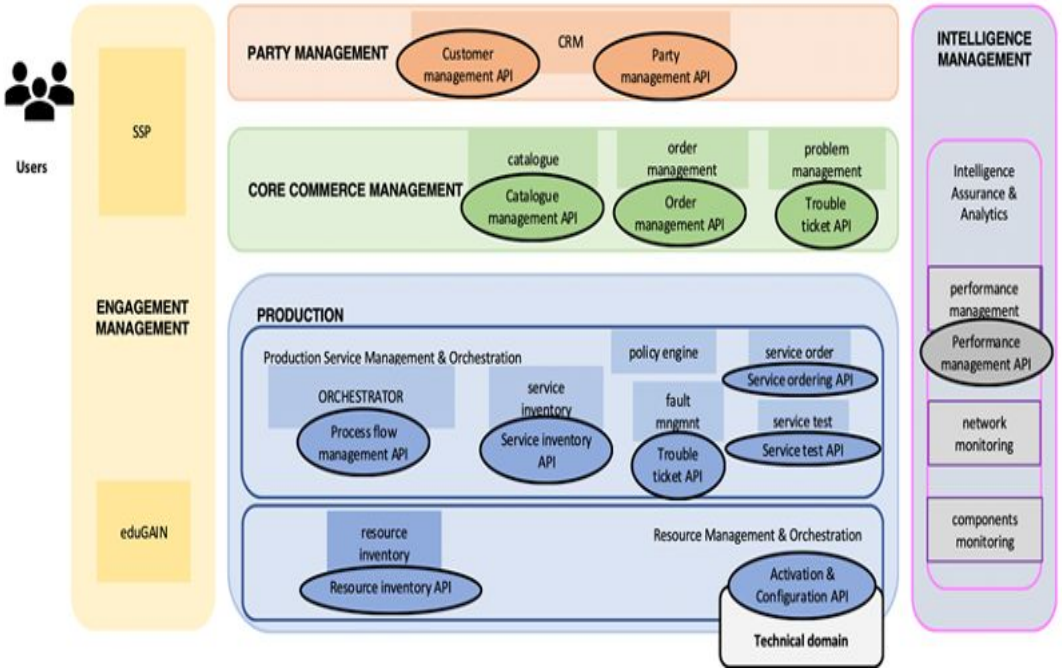
Service Provider Architecture Platform

SPA components available via NMaaS



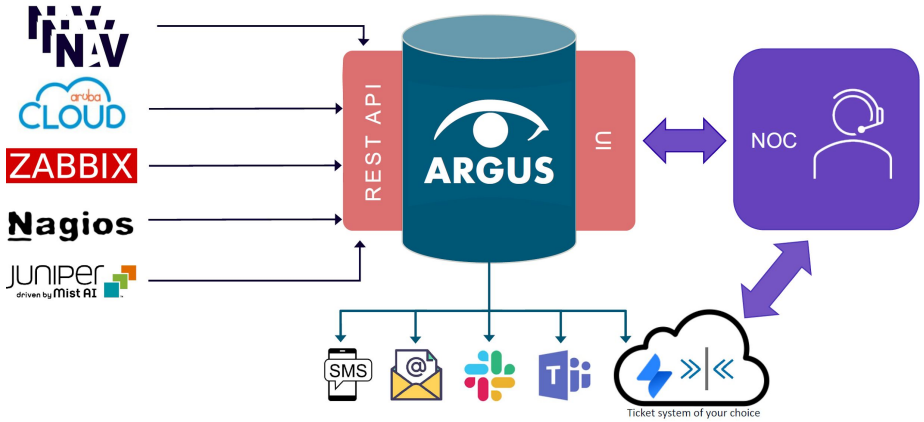
https://nmaas.eu

SPA architecture mapped to TMF ODA



Argus - Alarm Aggregation and Correlation Tool

- A tool for network element and measurement system alarm correlation
- Tailored for the CNaaS use case where one Ops Centre manages multiple networks
- Developed and used by SIKT and SUNET
- Integrates alarms from NAV, Nagios, ZABIX, ArubaCloud, Zino,...



More information:

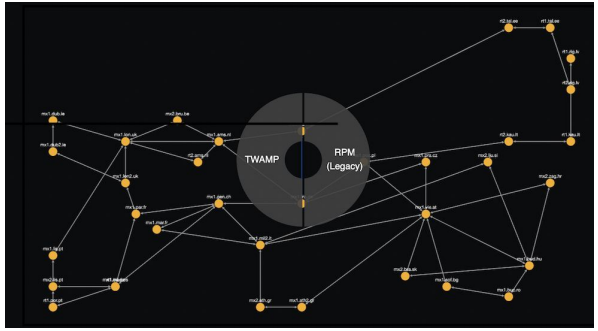
Argus Infoshare, 28 November 2022

https://wiki.geant.org/display/NETDEV/Argus

TimeMap

Backbone per-segment latency and jitter monitoring

Deploy



https://timemap.geant.org/

How to participate:

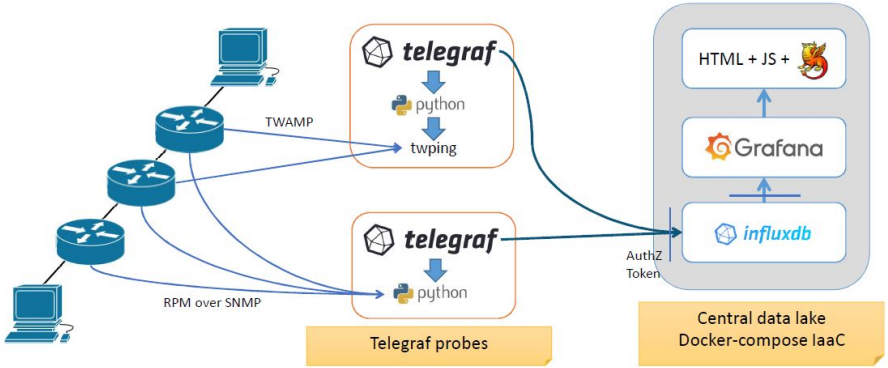
Use TimeMap measurement results

Implement TimeMap in your network

Connect your TimeMap to https://timemap.geant.org/

https://wiki.geant.org/display/NETDEV

timemap@lists.geant.org



Production-ready Services

Undergoing preparation and evaluation for production:

- **Router for Academia Research and Education – RARE**
- **GÉANT P4 Lab – GP4L**
- **Network Automation eAcademy**

Router for Academia, Research and Education (RARE)

RARE is an open source routing platform, used to create a network operating system (NOS) on commodity hardware (a white box switch).

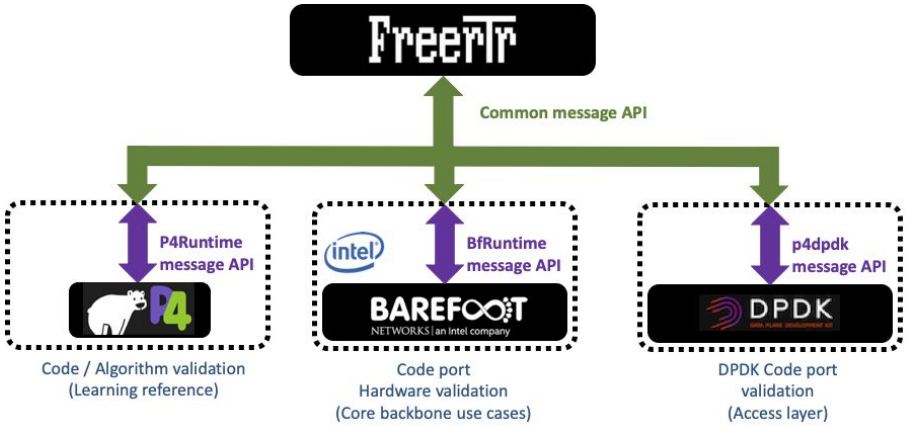
RARE uses FreeRtr as a control plane software and is thus often referred to as RARE/FreeRtr

FreeRtr

More information:
https://wiki.geant.org/display/rare

RARE Characteristics

- Uses Data Plane Programming (DPP) Language such as P4: **P**rogramming **P**rotocol-independent **P**acket **P**rocessors
- One control, several data planes: BMv2, TOFINO, DPDK, XDP



Visit

https://wiki.geant.org/display/RARE

for:

- Documentation
- Supported platforms
- Complete feature list

RARE Features

Supported Features:

- **Interior Routing Protocol**
  (IS-IS, OSPF, EIGRP, LSRP, PVRP)
- **Dataplane forwarding**
  (LDP, IS-IS-SR, OSPF-SR, LSRP-SR, VPLS-LDP)
- **External Routing Protocol**
  (BGP, BGP-RR, …)
- **Link local protocol**
  (LLDP, LACP, CDP, BFD,...)
- **Network management**
  (TACACS, TELNET, SSH, Lightweight SNMP, Packet postcard telemetry, INT)

Missing a feature or need more information?

rare-dev@lists.geant.org

For updates subscribe to:

rare-users@lists.geant.org

Dataplane forwarding

Feature	status	comment
LDP	COMPLETED	Label Distribution Protocol label distribution control protocol
IS-IS-SR	COMPLETED	IS-IS - Segment Routing extension
OSPF-SR	COMPLETED	OSPF - Segment Routing extension
LSRP-SR	COMPLETED	Link State Routing Protocol - Segment Routing extension
VPLS-LDP	COMPLETED	Virtual Private LAN Service (VPLS) - Using Label Distribution Prot

Interior Routing Protocol

Feature	status	comment
IS-IS	COMPLETED	-
OSPF	COMPLETED	-
EIGRP	COMPLETED	-
LSRP	COMPLETED	Link State Routing Protocol (FreeRouter specific IGP)
PVRP	COMPLETED	Path Vector Routing Protocol (FreeRouter specific IGP)

External Routing Protocol

Feature	status	comment
RFC4271	COMPLETED	BGP
RFC4456	COMPLETED	BGP Route reflection
RFC5065	COMPLETED	BGP Confederation
RFC7911	COMPLETED	BGP add-paths
RFC5364	COMPLETED	BGP/MPLS IP Virtual Private Networks
RFC4761	COMPLETED	Virtual Private LAN Service (VPLS) - Using BGP for Auto-Discovery and Signalling
RFC4762	COMPLETED	Virtual Private LAN Service (VPLS) - Using LDP for Auto-Discovery and Signalling
RFC6624	COMPLETED	Layer 2 Virtual Private Networks - Using BGP for Auto-Discovery and Signalling

Feature	status	comment
TACACS	COMPLETED	-
TELNET	COMPLETED	-
SSH	COMPLETED	-
Lightweight SNMP	ON-GOING	-
Packet postcard telemetry	FEASABILITY STUDY	-
INT	FEASABILITY STUDY	Inband Network Network T

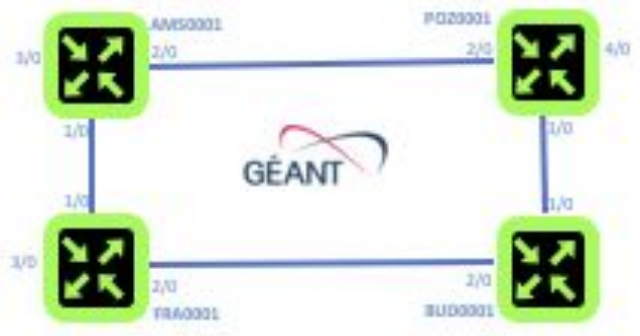
Complete feature list

Type	Test #	Name	P4		DPDK	XCID
acl	01	copp	✓	✓	✓	N/A
acl	02	ingress access list	✓	✓	✓	N/A
acl	03	egress access list	✓	✓	✓	N/A
acl	04	nat	✓	✓	✓	N/A
acl	05	vlan ingress access list	✓	✓	✓	N/A
acl	06	vlan egress access list	✓	✓	✓	N/A
acl	07	bundle ingress access list	✓	✓	✓	N/A
acl	08	bundle egress access list	✓	✓	✓	N/A
acl	09	bundle vlan ingress access list	✓	✓	✓	N/A
acl	10	bundle vlan egress access list	✓	✓	✓	N/A

GÉANT P4 Lab – GP4L

Initially aimed to **validate the RARE/FreeRtr** open source routing stack software

- 4 switches in Europe: AMS, POZ, FRA, BUD

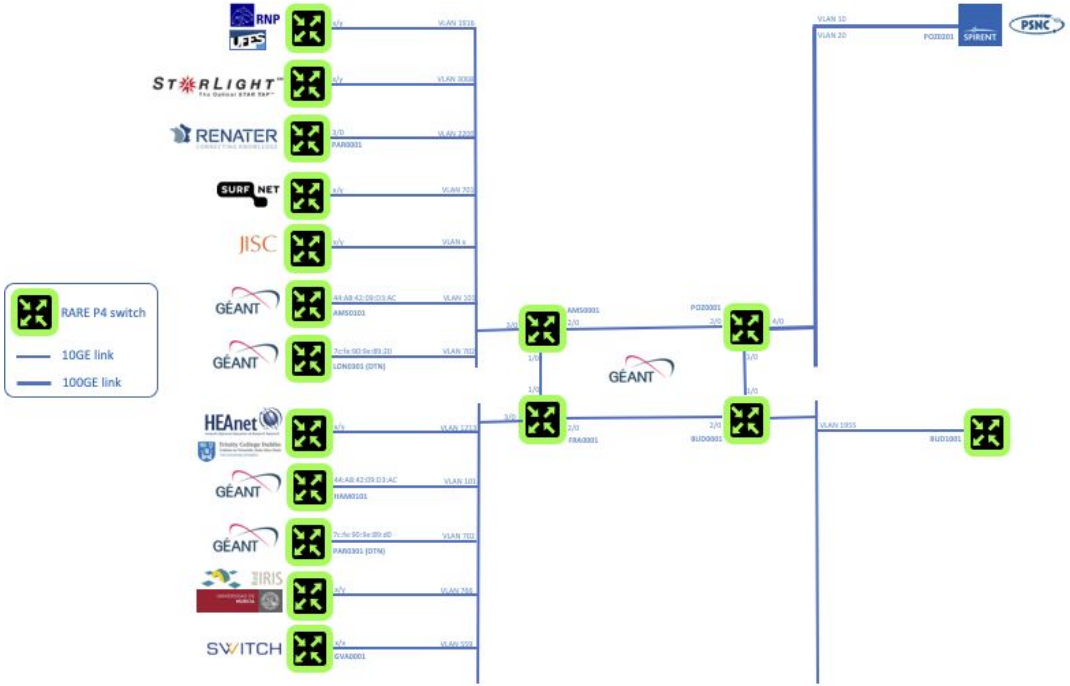


With growing interest, offering **experimental dataplane programming facilities** to researchers to perform geographically distributed network experiments:

- With the usage of RARE/FreeRtr NOS
- Using a clean slate environment (i.e use exclusively GP4L without RARE/FreeRtr dataplane & control plane)

GP4L
GÉANT P4 LAB

GP4L Going Global



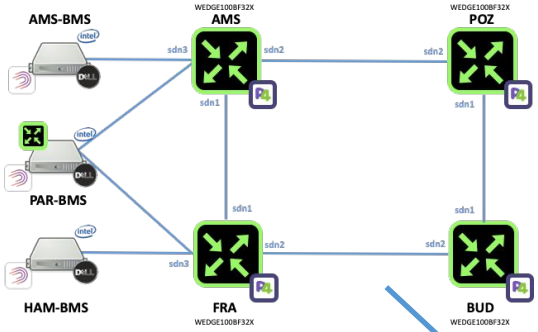
Deploy | Collaborate | Contribute

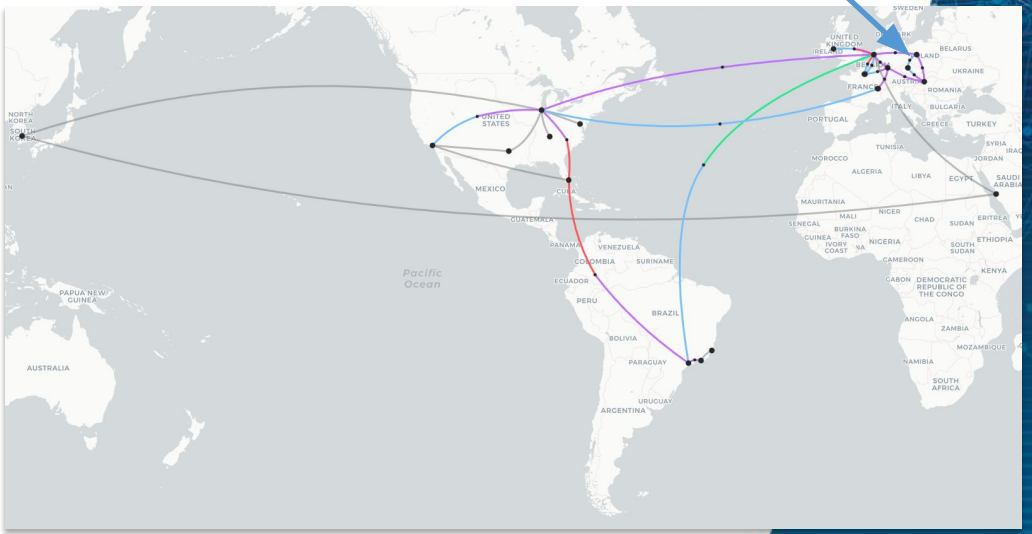
Global P4 Lab

More than 20 locations worldwide

Used for different use cases:

- RARE, GÉANT project, EU
- PolKA – an innovative routing paradigm, UFES Brazil
- Flow label/IPv6 identification, CERN Switzerland
- Bier/AMT - a cost effective multicast architecture, RARE+Juniper
- Topology Monitoring with BGP-LS
- GNA-G DIS Demo in Nov 2022 at SuperComputing22, Dallas, US





More information
https://wiki.geant.org/display/gp4l

Network eAcademy - Automation

Raising the bar for Orchestration, Automation and Virtualisation (OAV) and supporting NRENs in their digital transformation efforts

Activities

- Training Program
- Architecture analysis and mapping
- Terminology
- Community Portal
- Maturity Model

Contribute Collaborate Learn Share

Network eAcademy - Automation Training Program

Created from the community for the community helps to learn about OAV

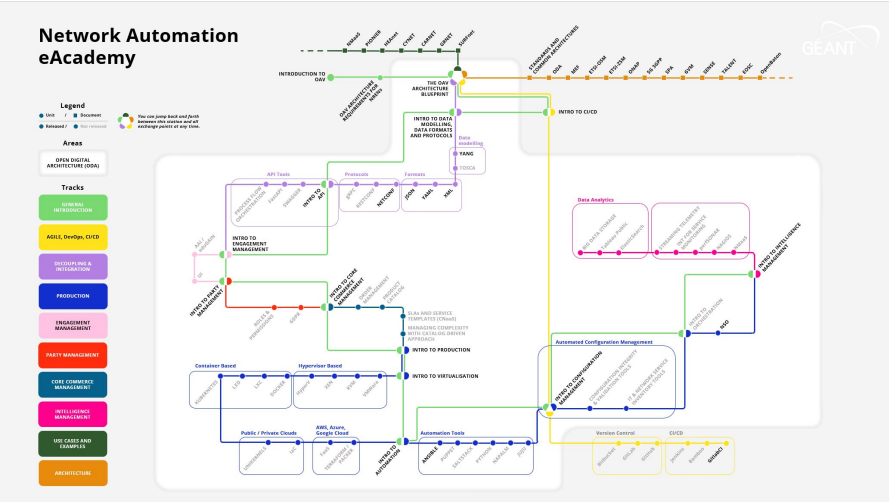
- 25 modules published in several categories:
  - Introduction courses
  - TM Forum
  - DevOps concepts
- Structured as Moodle courses with:
  - Videos, documents with scripts, links and quizzes
  - Use cases and examples
- More than 1,300 users viewed the courses so far
- Want to share your content? Contact: oav@lists.geant.org

Courses are available via the GLAD e-Academy portal

Access via eduGAIN and social networks accounts

Contribute Collaborate Learn Share

Training (Metro) Map



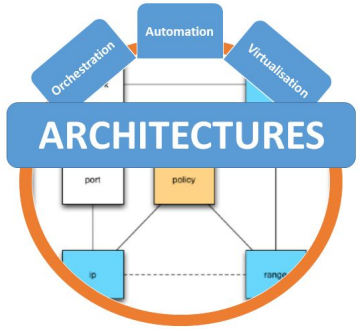
Interactive training metro map helps navigate through topics and complexity level

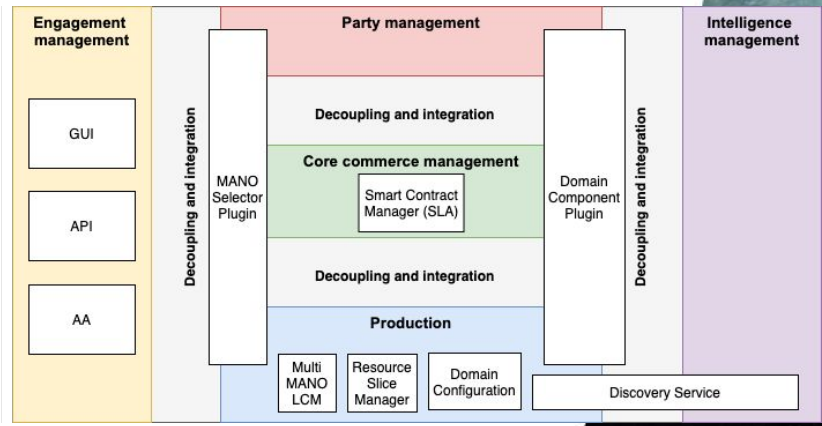
https://wiki.geant.org/display/NETDEV/OAV+Training+Portal

Contribute Collaborate Share

Network eAcademy - Automation Architecture analysis and mapping

- Analysis of components and functionalities
- Supports interoperability, integration and growth
- TM Forum Open Digital Architecture (ODA) selected as Technical Reference Model (TRM) Architecture
- Mapping completed for numerous use cases:
  - **NRENs:** SURF, CYNET, CARNET, PSNC, HEAnet, GRNET, GÉANT
  - SPA, NMaaS, TALENT, 5G
  - Templates and white papers available!





To map your architecture, contact:

oav@lists.geant.org

Contribute Collaborate Share

Network eAcademy - Automation
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

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

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	*An architecture component is a nontrivial, nearly independent, and replaceable part of a system tha well-defined architecture.* • TM Forum Reference, TMF071 ODA Terminology, TMF071, Release 19.0.1, October 2019
Architecture principles	*Architecture principles define the underlying general rules and guidelines for the use and deployme organisation. They reflect a level of consensus among the various elements of the enterprise, and fo decisions.* • based on https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap29.html

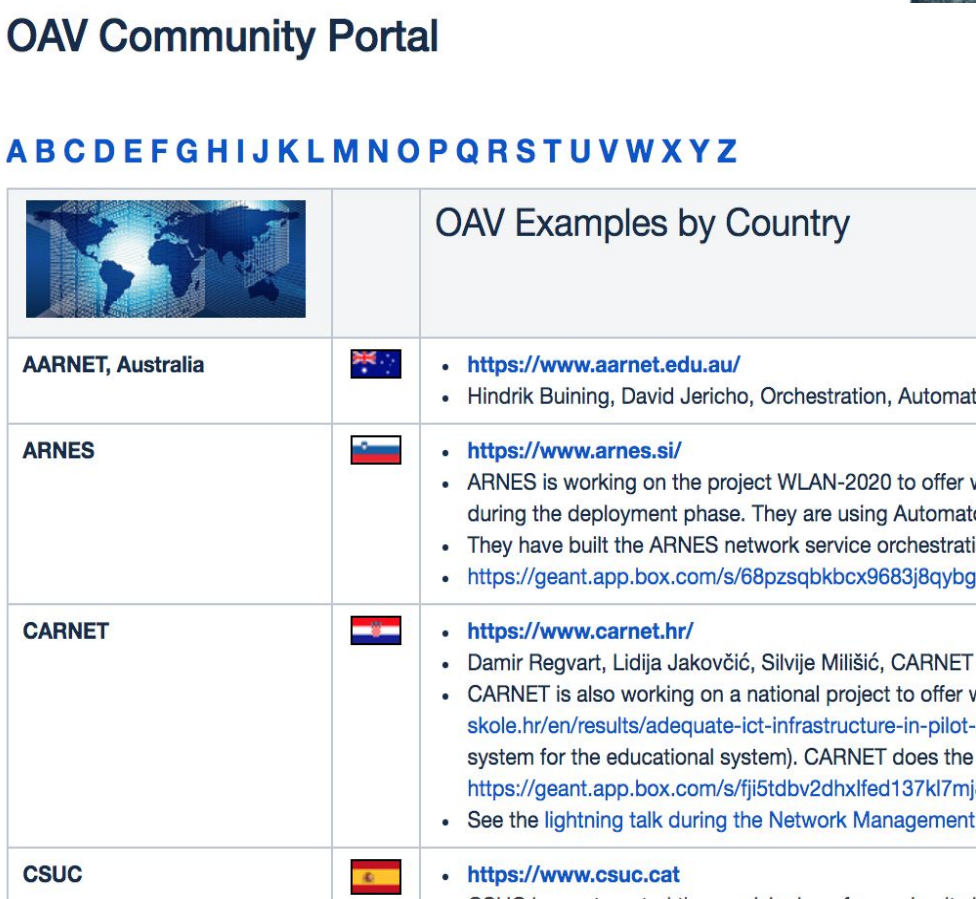
Contribute Collaborate Share

Network eAcademy - Automation Community Portal

Lists OAV examples and use cases worldwide, including, but not limited to:

- OAV Architecture
- WiFi
- CNaaS – Campus Network Management as a Service
- L2, L3 circuit provisioning
- Service orchestration
- Schools

Contact oav@lists.geant.org to share your OAV work!



Network eAcademy - Automation
OAV Maturity Model

A self-assessment survey to:

- Identify current state and needs
- Capture best practices
- Promote self-improvement
- Contribute to future progress

Four Dimensions

- Architecture & Technology
- Processes & Services
- Vision & Strategy
- People & Organisation

Six Stages

- None
- Ad Hoc
- Use-case based
- Integrated
- Proactive
- Self*

[Take the OAV Maturity survey]!

[More information]

[Contact the team]

Research and Development

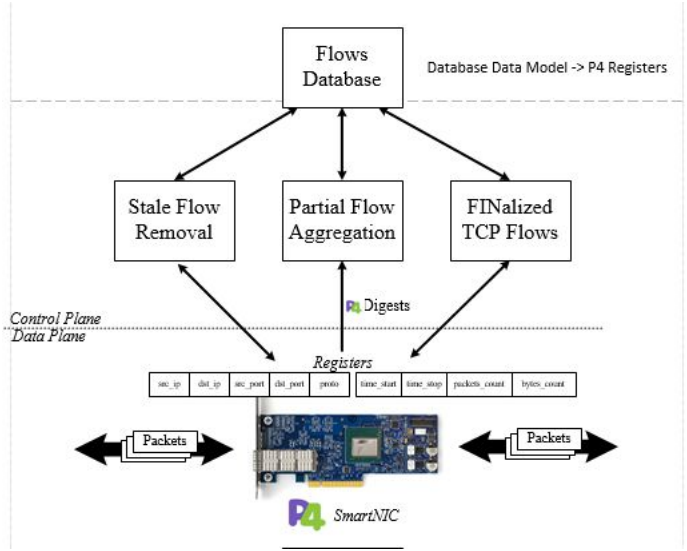
Network Telemetry

- P4-Based Flow Monitoring
- In-Band Network Telemetry (INT) using Data Plane Programming (DPP)

Optical Time and Frequency Networks (OTFN)

Quantum Key Distribution (QKD)

P4-based flow monitoring



Development and testing of the P4 code for low cost unsampled flow extraction using:

- Our own P4 flow extractor and nfdump suite
- Prototype on Netronome P4-programmable cards
- Streaming to elasticflow

Analysis of the system capabilities:

- Using high speed CAIDA PCAP files (2Mpps)
- Number of flows and packets that can be processed
- Flow Accuracy - More than 99% flows correctly captured @ 2M packets per second

Results to be published in November:

- White paper
- 17th SIG-NOC meeting in Paris

In-Band Network Telemetry (INT) using Data Plane Programming (DPP)

Monitoring traffic at high frequency for troubleshooting purposes

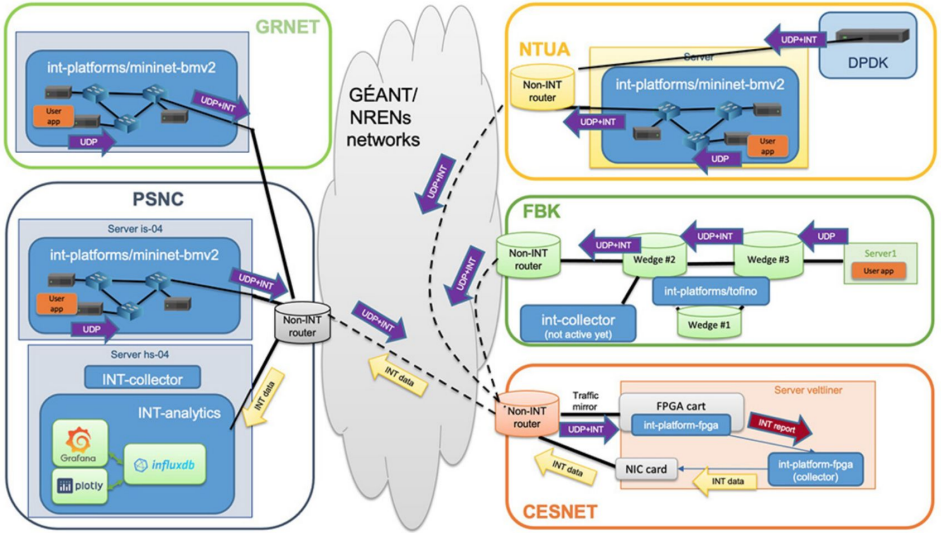
Testbed: 5 countries over a production network

Implemented: INT Source, Transit and Sink node

Platforms: FPGA, Intel TOFINO, DPDK and BMv2

Publications:

- Timestamping and Clock Synchronisation in P4-Programmable Platforms
- In-Band Network Telemetry Tests in NREN Networks



Optical Time and Frequency Networking – OTFN

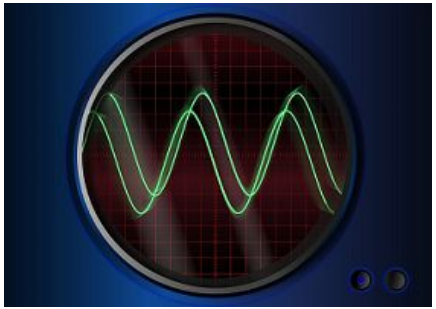
Exploring approaches for deploying T&F services in NREN networks and Supporting NRENs in implementing T&F services

Publications:

- Ultrastable Frequency Transfer in L-Band
- Distributing New Performant Time and Frequency Services over NREN Networks
- Management and monitoring of time and frequency services – coming soon

More information:

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



Quantum Key Distribution (QKD)

Assessing the quantum cryptography use cases within GÉANT and NREN infrastructures

Activities:

- Survey on Quantum projects
- Quantum Technologies Status Overview White Paper
- Knowledge sharing - infoshares
  - QKD deployment examples 24 Nov 2022
- Quantum Simulators
- Long-haul PoC project
- Open Quantum Group Meeting
- Quantum Internet Hackathon 2022 co-organisation with RIPE NCC
- QKD Wiki

Join the Quantum Internet Community Meetup, Today, 25 October 17:30 - 18:30

More information:
https://wiki.geant.org/display/NETDEV/QKD

Completed Work

White Box

Data Transfer Nodes

Campus Network Management as a Service

White Box

Exploring NREN's use cases for using open source OS on a commodity hardware:

- Customer Premises Equipment (CPE): FUNET, Renater
- Internet eXchange Point (IXP): Renater
- Data Centre: GRNET

Publications and infoshares:

- White Box Total Cost of Ownership
- White Box Evaluation
- White Box Performance Testing and Evaluation
- White Boxes in NREN Context, infoshare

More information:

https://wiki.geant.org/display/NETDEV/WB

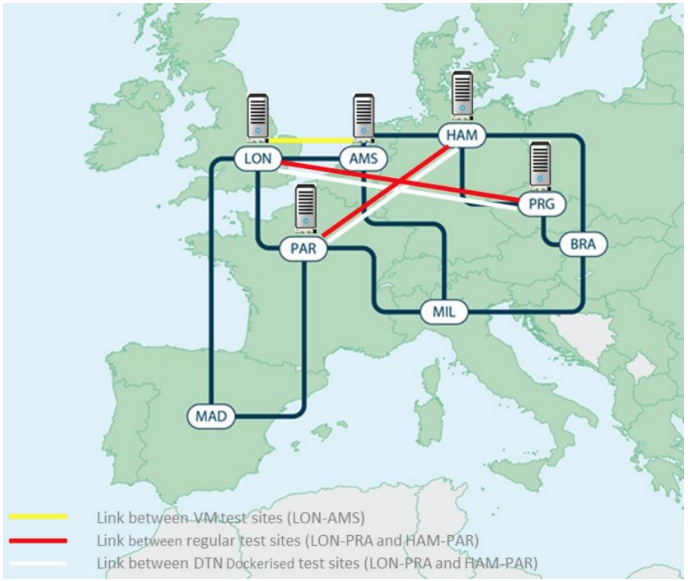
Data Transfer Nodes

Exploring NREN needs and usage of DTN solutions:

- NREN Survey
- Review of DTN hardware and tools
- DTN tests
- Optimising DTN Configurations

Publications:

- Data Transfer Node (DTN) Tests on the GÉANT Testbeds Service (GTS)
- Data Transfer Nodes: How Fast can your Data Travel?, infoshare



More information:

https://wiki.geant.org/display/NETDEV/DTN

Campus Network Management as a Service (CNaaS)

Evaluating use cases for Orchestration, Automation and Virtualisation (OAV)

CNaaS Service Definition Checklist

3 Infoshares (presentations and recordings available):

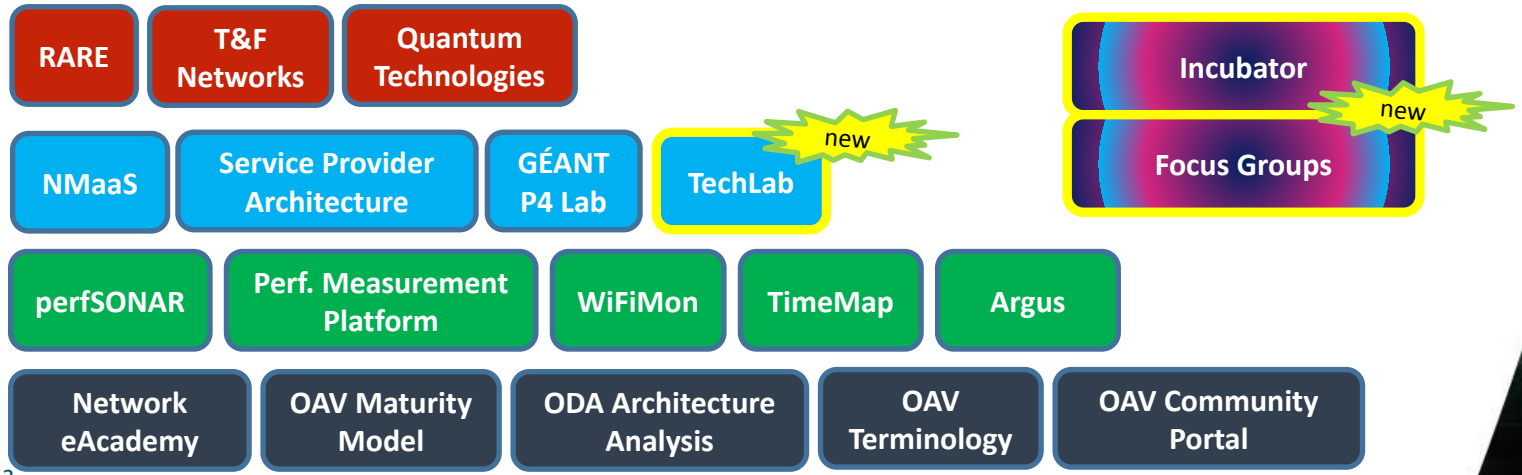
- Offering Campus Network Management as a Service: Challenges and Lessons Learnt
- Tools for Campus Network Management as a Service
- Campus Network Management as a Service

More information:

https://wiki.geant.org/display/NETDEV/CNaaS

Continuation of the GÉANT project – GN5-1

- Smooth transition from the current project
- Duration: 1 Jan 2023 – 31 Dec 2024
- Leaders: Ivana Golub (PSNC), Pavle Vuletić (UoB)
- Budget: 3,3 mil EUR
- Continuing BaU, innovation through the Incubator



Collaborations

Global Network Advancement Group (GNA-G)

Special Interest Group - Network Operations Centre (SIG-NOC)

Global Network Advancement Group (GNA-G)

- A community of Research & Education (R&E) network professionals worldwide
- Working together to align resources and achieve efficient global interconnections for global science collaborations and transnational education
- Work is done in Working Groups:
  - AutoGOLE/SENSE
  - GREN Map
  - GNA-G Routing WG
  - GREN Connecting offshore students
  - Data Intensive Science
  - Network Automation

More information:

https://www.gna-g.net/

Special Interest Group - Network Operations Centre (SIG-NOC)

An **open forum for network operators** to exchange technical and business oriented information, knowledge, ideas and best practices.

More information: SIG-NOC wiki

Next meeting: 16-17 November 2022, Paris
Registration: https://events.geant.org/event/1296/

More about our work @ upcoming events

2022

- **10 November** — NOG.HR Meetup
- **16-17 November** — 17th SIG-NOC
- **23 November** — GNA-G Community VC (6-8 am UTC & 8-10 pm UTC)
- **24 November** — In-band Network Telemetry infoshare
- **25 November** — Quantum Key Distribution deployments infoshare
- **28 November** — Argus infoshare
- **1-2 December** — Quantum Internet Hackathon
- **8 December** — I2 TechEx:
  * Time and Frequency Services in NREN Networks
  * Monitoring the Hidden: TimeMap
  * Network Automation eAcademy

2023

- **14 April** — Celebrating The World Quantum Day

https://events.geant.org/

Find out more about the WP6 work

https://wiki.geant.org/display/NETDEV

Production services

Development

Presentations

Recordings

White Papers

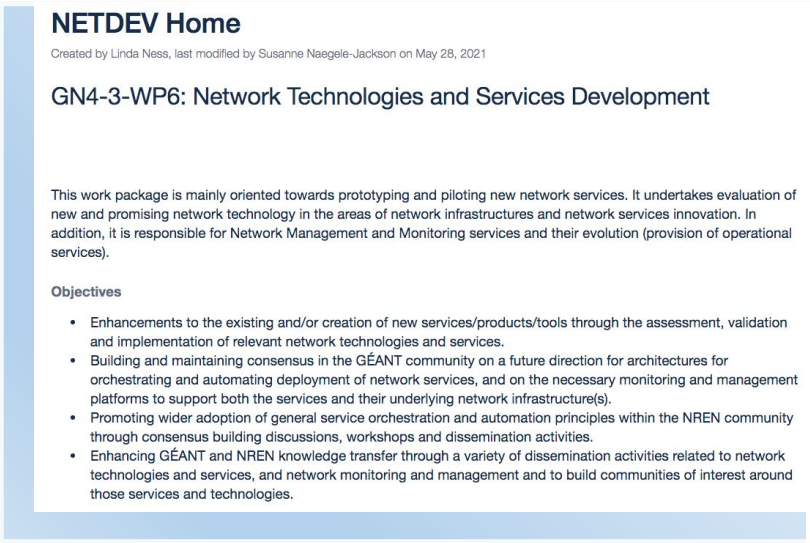
OAV Community Portal

Code repositories

Deliverables and Milestones

OAV Training

Digital Architecture Mapping



NETDEV Home

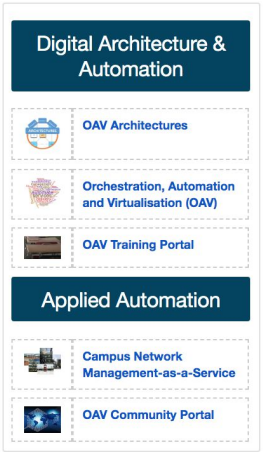
Created by Linda Ness, last modified by Susanne Naegele-Jackson on May 28, 2021

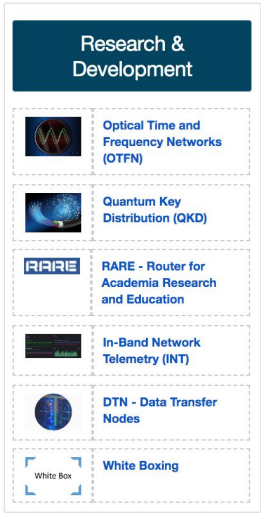
GN4-3-WP6: Network Technologies and Services Development

This work package is mainly oriented towards prototyping and piloting new network services. It undertakes evaluation of new and promising network technology in the areas of network infrastructures and network services innovation. In addition, it is responsible for Network Management and Monitoring services and their evolution (provision of operational services).

Objectives

- Enhancements to the existing and/or creation of new services/products/tools through the assessment, validation and implementation of relevant network technologies and services.
- Building and maintaining consensus in the GÉANT community on a future direction for architectures for orchestrating and automating deployment of network services, and on the necessary monitoring and management platforms to support both the services and their underlying network infrastructure(s).
- Promoting wider adoption of general service orchestration and automation principles within the NREN community through consensus building discussions, workshops and dissemination activities.
- Enhancing GÉANT and NREN knowledge transfer through a variety of dissemination activities related to network technologies and services, and network monitoring and management and to build communities of interest around those services and technologies.





Thank you

Any questions?

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www.geant.org

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