



NMaaS Virtual Labs for Education

Streamlining the Organization of Hands-On Educational Exercises

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Agenda

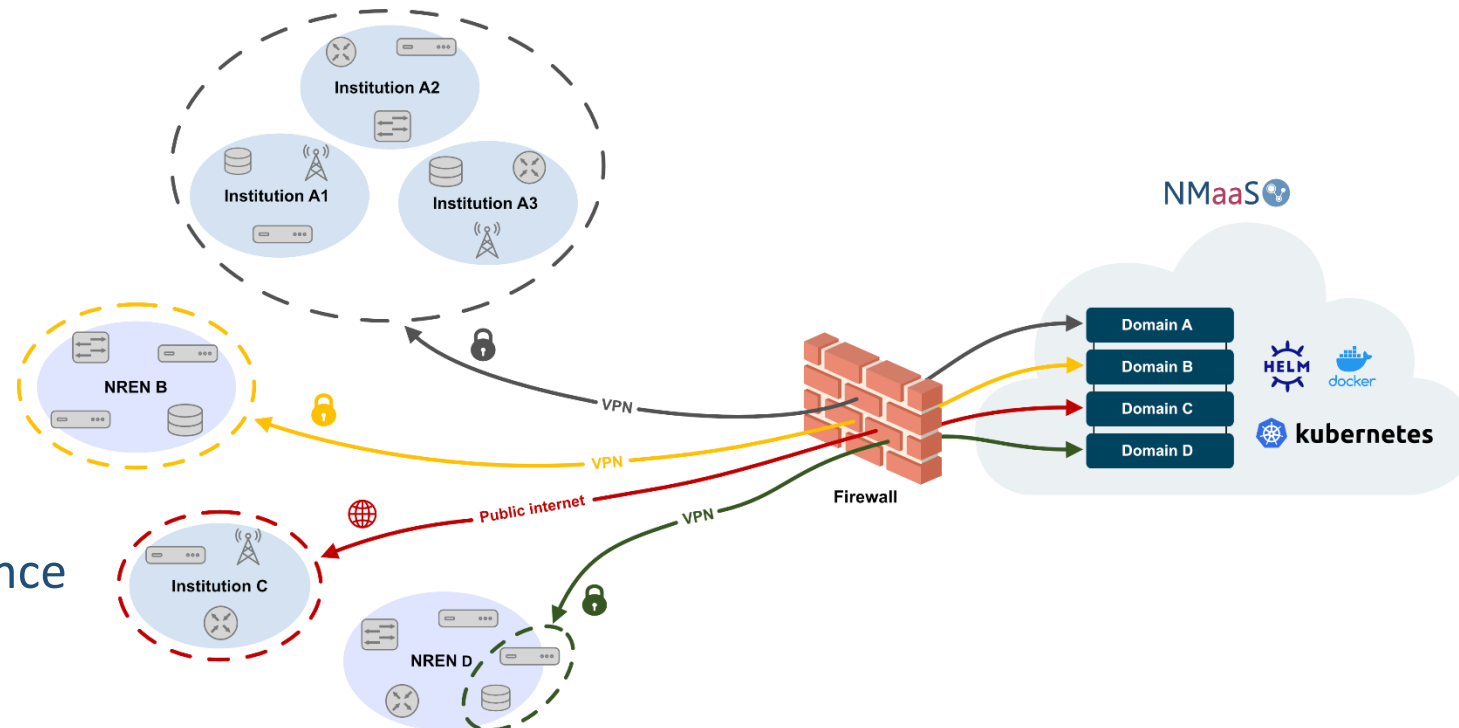
- NMaaS Introduction
- NMaaS for Virtual Labs
- Virtual Labs in Action (demo)
- How to Run My Own Virtual Labs
- Conclusion and Plans for the Future



Introduction to NMaaS

NMaaS is a open source multi-tenant cloud-based platform for effortless, on-demand deployment of software tools and applications

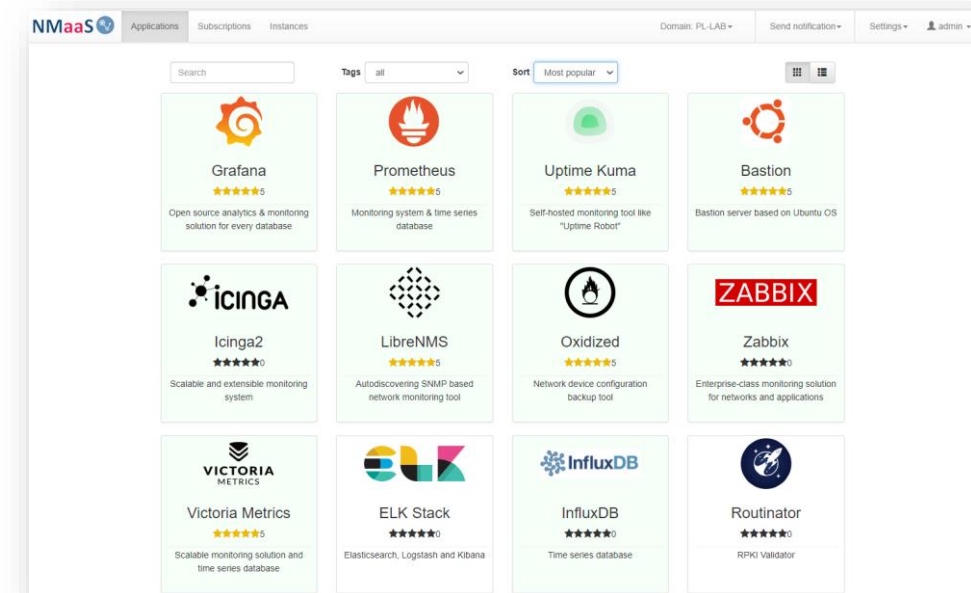
- Kubernetes-based infrastructure
- Software based VPNs
- Wide and easily extendable catalogue of applications
- Web-based user interface
- Simple application deployment process
- Automated GitOps-based application instance configuration management





NMaaS Use Case: Network management

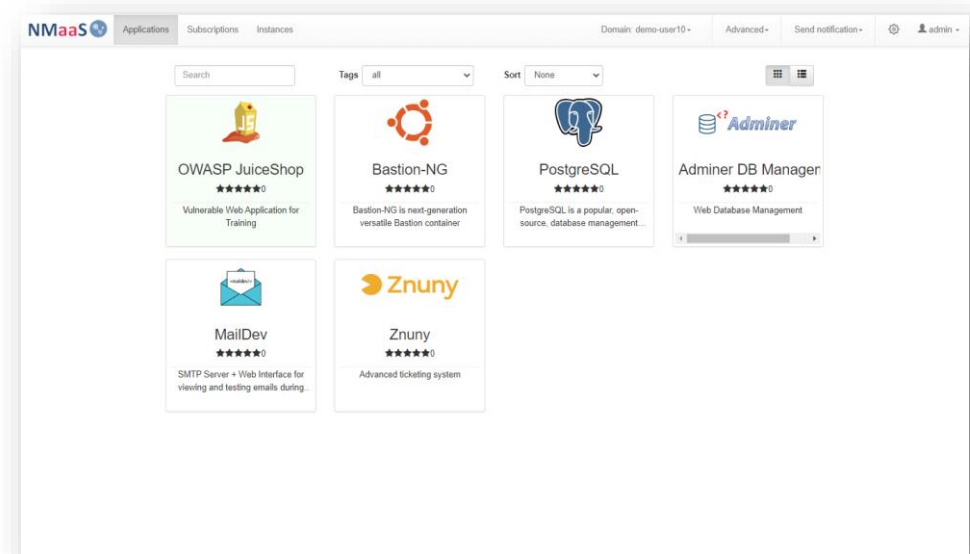
- Aimed at supporting National Research and Education Networks (NRENs) and their end-institutions in monitoring their infrastructures
- Managed NMaaS service operated by the GÉANT Project (access Portal at <https://nmaas.eu>)
 - Production service since 2019
 - > 30 applications
 - > 30 domains (tenant environments)
- Current NMaaS users
 - NRENs
 - R&D Institutions and Projects
 - GN5 Project Teams (e.g. RARE team for GP4L monitoring)





NMaaS Use Case: Virtual Labs

- Recognizing the versatility of the platform, NMaaS is well suited to serve additional use-cases
- Deployment of virtual laboratories supports organizing hands-on exercises in a wide range of scenarios
- Work started in 2023
- Dedicated set of applications added to the catalogue
- Currently at the pilot phase



CTFd



Znuny



NMaaS for Virtual Labs

A New NMaaS Use-Case

NMaaS for Virtual Labs in a Nutshell

- The challenge of organizing hands-on educational exercises
 - Formal learning
 - Informal learning
- NMaaS as a general-purpose application catalogue
- Core idea: Deployment of educational exercises not fundamentally different from network management applications
 - Same underlying concept and technologies
 - Containerization, orchestration, isolation, multi-tenancy



Virtual Lab Stakeholders

Lab Managers

- Privileged users responsible for organizing the exercises
 - Professors
 - Teaching Assistants
 - Tutors
 - Course Managers
 - Administrators



Lab Participants

- Users taking part in a virtual lab exercise
 - Students
 - MOOC Participants
 - Trainees
 - Learners



What Does NMaaS Bring to the Table?

Benefits for Lab Managers

- **Reusable infrastructure** across multiple courses, or even institutions
- Granular management of participants and lab scenarios
- Extensive access control and personalization features

Benefits for Lab Participants

- Deployment of complex applications, bypassing hardware requirements
- Eliminating configuration overhead
- **Increased engagement** through gamification and lab environment personalization
- Playground for testing new software

Diverse set of applications, from different science domains

- Not limited only to computer science!

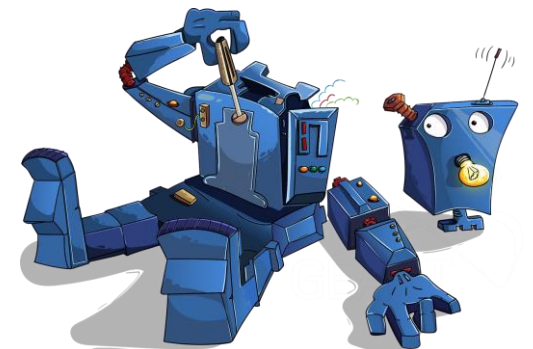
Extending NMaaS for Virtual Labs (1)

Adapting existing features and adding brand new ones:





- 👍 Domains
 - Personal space to manage existing application instances and deploy new ones for arbitrary virtual lab scenarios
 - Usually 1:1 mapping between a real person and a domain
 - Optionally multiple users can share a single domain (collaborative assignments)
 - Domains are persistent and can be reused by the same participant across virtual lab assignments

- 👍 Domain groups
 - Facilitate application deployment restrictions, what applications are available in what domain
 - The problem of personalized catalogs
 - A given domain group usually relates to a real-world course

👍 = Implemented 🏭 = In Development

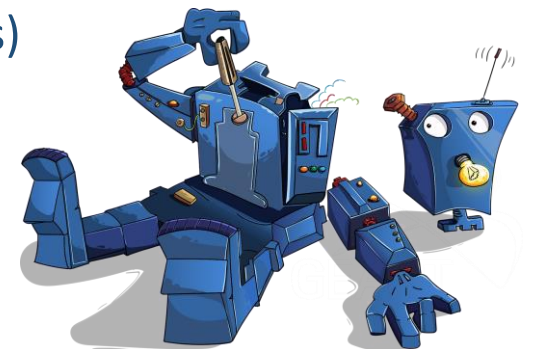


Extending NMaaS for Virtual Labs (2)

-  On-demand applications
 - Utilize the available infrastructure to its maximum
 - Inactive applications are turned off and are brought online upon the next request
 - Efficiency improvements due to the inherent access patterns of virtual lab exercises
-  Bulk domain creation
 - Batch enrolment of large groups of users into the platform
 - Creation of both new domains and relevant domain groups
 - Support for exports from external systems (e.g., LMS)
-  Bulk application deployments
 - Lab managers deploy multiple application instances across different domains at once
 - NMaaS is transparent to lab participants
-  Automation aspects
 - Automatic profile provisioning upon first federated login (domain, VPN profiles)
 - Network restrictions

 = Implemented

 = In Development





NMaaS Virtual Labs in Action

Demo of the new NMaaS features



Deploying New Domains in Bulk as a Lab Manager

Network Management as a Service (NMaaS) provides a portfolio of network management applications run as dedicated per-user instances in the cloud.

GÉANT's NMaaS service includes three aspects: providing, managing and maintaining the infrastructure of the NMaaS service portal, platform and selected tools, supporting users in using the system, and the selected tools for monitoring their networks via NMaaS, as well as supporting users that contribute their software to NMaaS system.



Target users

NMaaS users are organisations that do not want to own NMS infrastructure themselves and/or want to outsource network management, as well as organisations and/or individuals that are searching for quality network management software or who want to share their software within the community.

NMaaS Marketplace

NMaaS Marketplace is a catalogue of available open source tools, supported by community, distributed free, chosen by administration. There is also place for your application choice - you can propose new applications.



Cost reduction

With NMaaS, users do not have to bear the ownership costs and risks related to maintenance and control of the network management infrastructure.

Restricting Available Applications with Domain Groups

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Deploying an Application as a Lab Participant

















The screenshot displays the NMaas web interface. At the top left is the NMaas logo. The navigation bar includes 'Applications' (selected), 'Subscriptions', and 'Instances'. On the right, it shows 'Domain: demo-user01' and a user profile for 'demo-user01'. Below the navigation, there are search and filter controls: a search box, 'Tags' set to 'all', and 'Sort' set to 'None'. The main content area features five application cards:

- OWASP JuiceShop**: Represented by a yellow shopping bag icon with 'JS' on it. Description: 'Vulnerable Web Application for Training'. Rating: ★★★★★0.
- Bastion-NG**: Represented by an orange circular icon with four dots. Description: 'Bastion-NG is next-generation versatile Bastion container'. Rating: ★★★★★0.
- PostgreSQL**: Represented by a blue elephant icon. Description: 'PostgreSQL is a popular, open-source, database management...'. Rating: ★★★★★0.
- Adminer DB Managen**: Represented by a blue database icon and the text 'Adminer'. Description: 'Web Database Management'. Rating: ★★★★★0.
- MailDev**: Represented by a blue envelope icon with '<maildev/>' on it. Description: 'SMTP Server + Web Interface for viewing and testing emails during..'. Rating: ★★★★★0.

Deploying Applications in Bulk as a Lab Manager

NMaaS  Applications Subscriptions Instances Domain: GLOBAL Advanced Send notification  vojdark

Search Tags: all Sort: None  

 <p>LibreNMS ★★★★★0 Autodiscovering SNMP based network monitoring tool</p>	 <p>Oxidized ★★★★★0 Network device configuration backup tool</p>	 <p>Prometheus ★★★★★0 Monitoring system & time series database</p>	 <p>Grafana ★★★★★0 Open source analytics & monitoring solution for every database</p>
 <p>Bastion ★★★★★0 Bastion server based on Ubuntu OS</p>	 <p>perfSONAR pSConfig Web Admin ★★★★★0 Web-based UI for perfSONAR administrators</p>	 <p>LibreBooking ★★★★★0 Web-based calendar and schedule</p>	 <p>SPA SPA Inventory ★★★★★0 Resource and Service Inventory with TMF-compliant API</p>
 <p>Statping ★★★★★0 Status Page & Monitoring Server</p>	 <p>perfSONAR MaDDash ★★★★★0 Monitoring and Debugging Dashboard</p>	 <p>Debian repository ★★★★★0 Debian package repository based on Reprepro</p>	 <p>InfluxDB ★★★★★0 Time series database</p>
 <p>Jenkins</p>	 <p>ELK Stack</p>	 <p>perfSONAR esmond</p>	 <p>WiFiMon WiFiMon</p>

Exploring Additional Scenarios

The screenshot displays the NMaas application interface. At the top, there is a navigation bar with the NMaas logo and tabs for 'Applications', 'Subscriptions', and 'Instances'. The current domain is 'demo-user01' and the user is 'demo-user01'. A notification bar indicates 'To exit full screen, move mouse to top of screen or press F11'. Below the navigation bar, there is a search bar and filters for 'Tags' (set to 'all') and 'Sort' (set to 'None'). The main content area shows a grid of application cards:

- OWASP JuiceShop**: Vulnerable Web Application for Training. Rating: ★★★★★0.
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NMaaS Virtual Labs in the Real World

Reporting on experience from past pilots

NMaaS Virtual Lab Pilots

- Two pilots conducted in the past year at Ss. Cyril and Methodius University in Skopje, North Macedonia
- Different subject areas:
 - Cybersecurity
 - IT Service Management
- 75 lab participants in total
- Plans in place for additional pilots in the near future



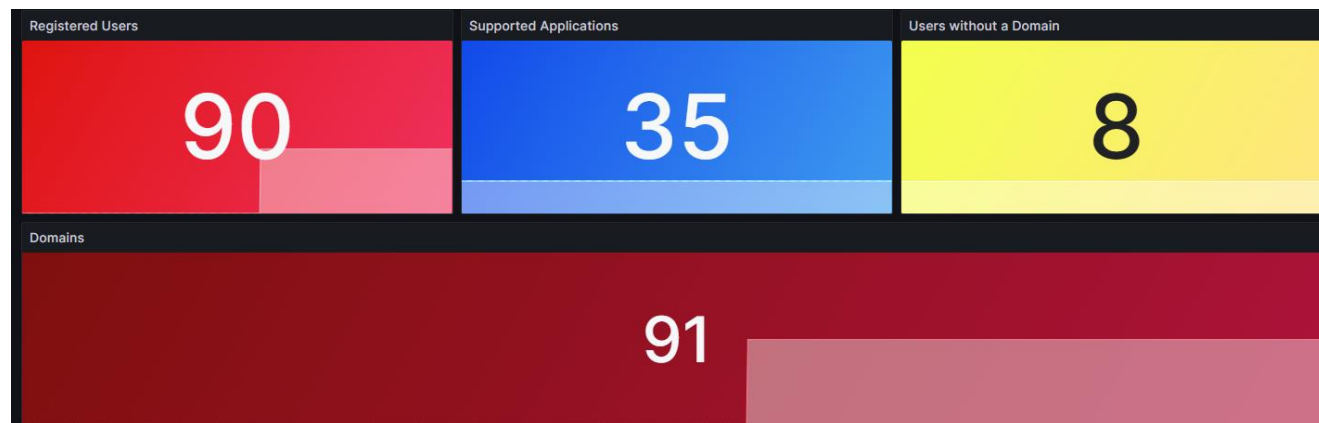
NMaaS for Virtual Laboratories – Cybersecurity Pilot

- **First real-world test** with 45 participants from a single university course
- Virtual lab related to cybersecurity and ethical hacking
- Applications deployed by the users themselves using the NMaaS Portal
- **Idle applications are scaled down** to conserve resources
- CTF style competition with a dedicated vulnerable web application per participant
- **Gamification** through centralized flag submission system and scoreboard



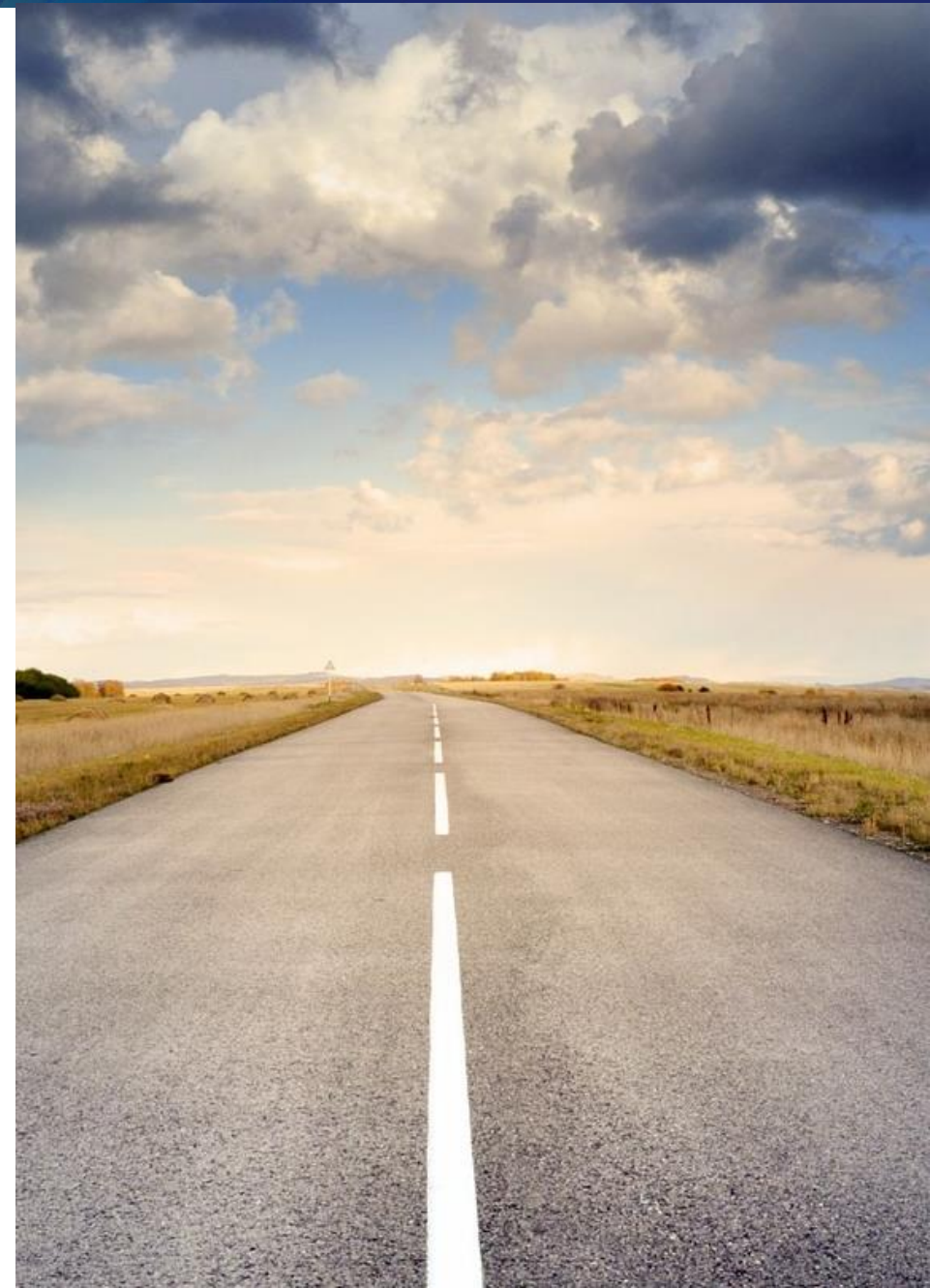
NMaaS for Virtual Laboratories – IT Service Management Pilot

- 30 participants from an IT Service Management Course
- Instances of the OTRS (Znuny) ticketing system deployed in bulk by the lab managers
- **NMaaS is transparent to lab participants**, only information on how to access the personalized instances is received (URL, username, password)
- Instances are long-lived, throughout the complete duration of the course



Virtual Lab Plans for the Future

- Additional virtual lab scenarios
 - JupyterLab
 - More vulnerable applications for CTF training
- Exploring additional use-cases
 - Deployment of virtual machines (not only containers)
 - Use for scientific computing, leveraging specialized hardware (i.e., GPUs)
- Building a community around NMaaS
 - Sharing course materials and know how
 - Adding new applications





How to Run My Own Virtual Labs

Taking NMaaS for a spin...

How can you use the managed GÉANT NMaaS service?

To set up your own NMS on the central GÉANT NMaaS

- Request a domain on NMaaS **production** instance:
<https://nmaas.eu> (fully supported)

To run a pilot of your Virtual Lab on infrastructure provided by the GÉANT Project

- Contact the NMaaS team
- Dedicated NMaaS instance exists (currently limited to pilot scale)

The screenshot shows the NMaaS User Guide website. The main content area is titled "1. NMaaS Domains" and contains the following text:

A domain in NMaaS corresponds to a dedicated and isolated tenant environment created within the system for particular institution, project, team or in general a group of users.

There are two highlighted sections:

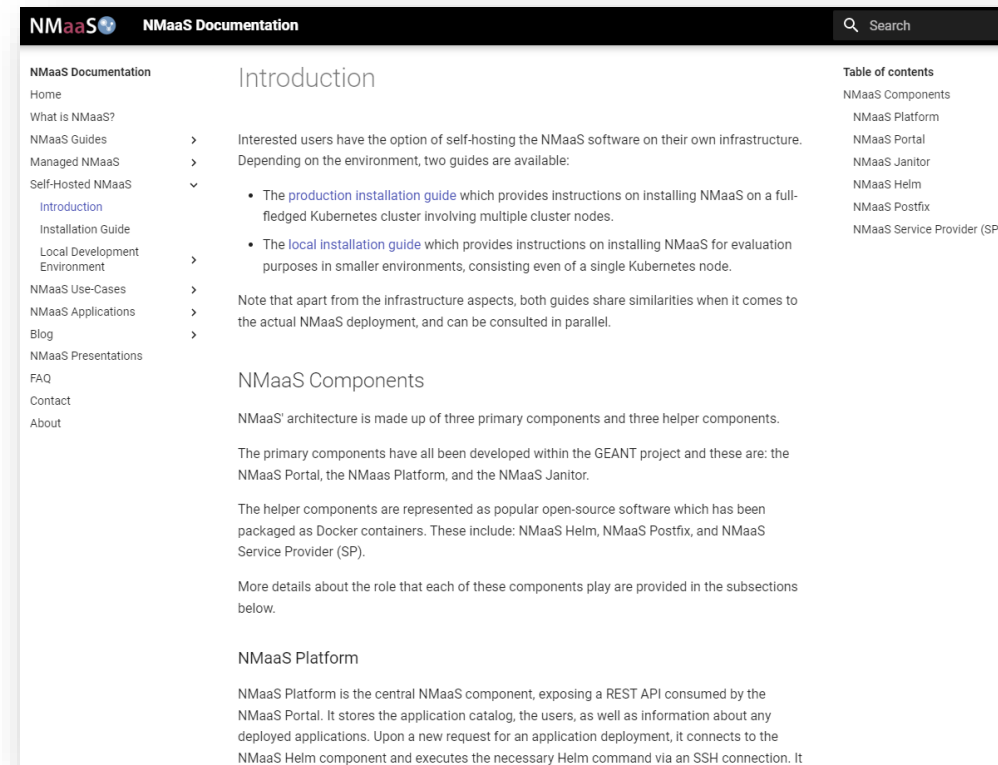
- Domain Assignment**: User can be assigned to multiple domains.
- Requesting a New Domain**: In order to apply for a new domain creation submit the form available at https://nmaas.eu/about?type=NEW_DOMAIN_REQUEST.

The right sidebar contains a "Table of contents" with the following items:

- NMaaS Domains
- Introduction to NMaaS User Roles
 - Global Level Roles
 - Domain Level Roles
- NMaaS Portal
 - About
 - User Login
 - User Registration
- Application Market
- Application Subscriptions and Instances
- Application Instance Deployment
 - Application Details View
 - Initiating Application Instance Deployment
 - Application Instance Initial Configuration
 - Accessing Application Instance
 - Configuring Application Instance
 - Managing Application Instance Upgrades
 - Initiating Application Instance Removal
 - Managing Failed Application Instance Deployments
- User Settings
 - User Profile
 - Setting a User's Default Domain

How can I run Virtual Lab on my own?

- Two options for running a **self hosted instance of NMaaS**
 - Local evaluation environment on a single node cluster
 - On an existing full-fledged Kubernetes cluster (suitable for Virtual Lab)
- Complete guide available at <https://docs.nmaas.eu>
- **NMaaS team will provide all required support**



The screenshot displays the NMaaS Documentation website. The page title is "Introduction". The left sidebar contains a navigation menu with items: Home, What is NMaaS?, NMaaS Guides, Managed NMaaS, Self-Hosted NMaaS (expanded to show Introduction, Installation Guide, Local Development Environment), NMaaS Use-Cases, NMaaS Applications, Blog, NMaaS Presentations, FAQ, Contact, and About. The main content area discusses self-hosting options, mentioning a production installation guide for full-fledged clusters and a local installation guide for smaller environments. It also lists NMaaS components: NMaaS Portal, NMaaS Platform, and NMaaS Janitor, along with helper components like NMaaS Helm, NMaaS Postfix, and NMaaS Service Provider (SP). A table of contents is visible on the right side of the page.

Contact the NMaaS Team: nmaas@lists.geant.org

Subscribe to the NMaaS users list: nmaas-users@lists.geant.org



Conclusion and Plans for the Future

Buckle up, we are just getting started

Conclusion

- NMaaS as a versatile orchestration platform
 - Based on popular and well-known technologies
 - Open source (Apache 2.0, <https://github.com/nmaas-platform>)
 - Suitable for hosting diverse set of applications
 - **Not limited to a given use case**
- Virtual Lab development and deployments
 - Pilots underway
 - Interest raised from GN5 project partners from Greece, Croatia, Serbia and Poland
 - Planned upgrade of infrastructure to allow for deployment of production-grade Virtual Lab instances
- **You are welcome to share ideas and requirements**
 - Missing features or applications
 - Brand new use cases





Thank You

Documentation

NMaaS Users' Mailing List

Contact the NMaaS team privately

<https://docs.nmaas.eu/>

nmaas-users@lists.geant.org ([join](#))

nmaas@lists.geant.org



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