



# Orchestrated Deployment of Virtual Labs for Education with nmaas

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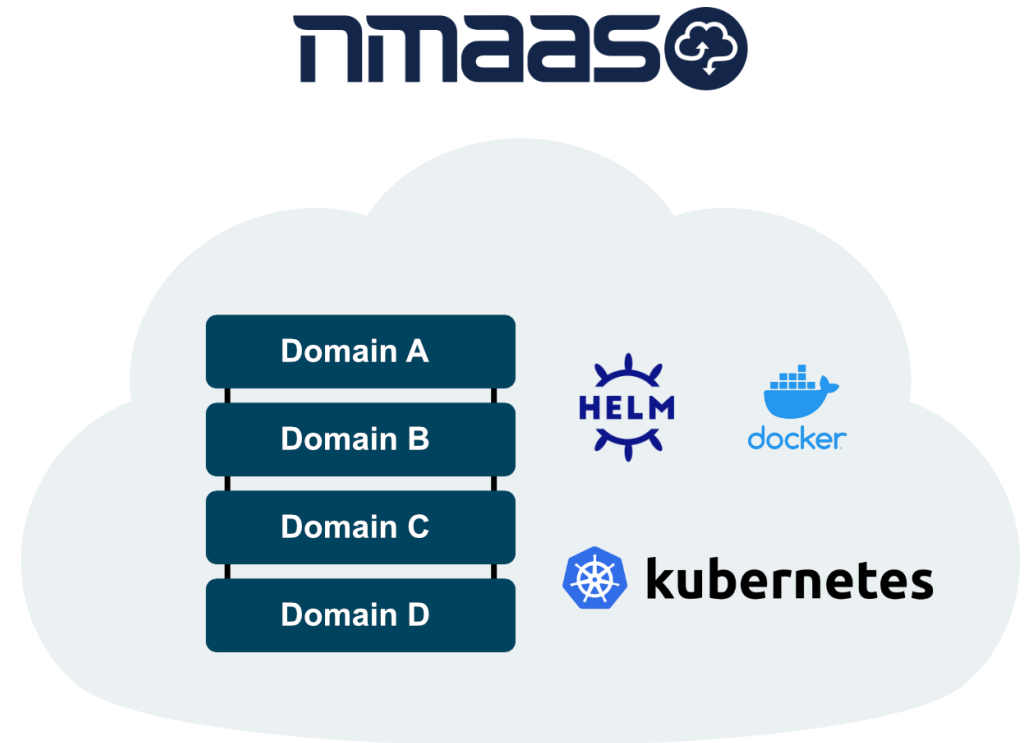
# Agenda

- Introduction to the nmaas Platform
  - Orchestration
  - GitOps Configuration
- nmaas in Practice
  - Virtual NOC
  - Virtual Lab
- Conclusion

# Introduction to nmaas

*nmaas* is an open-source framework for orchestrated on-demand deployment of applications in a cloud environment

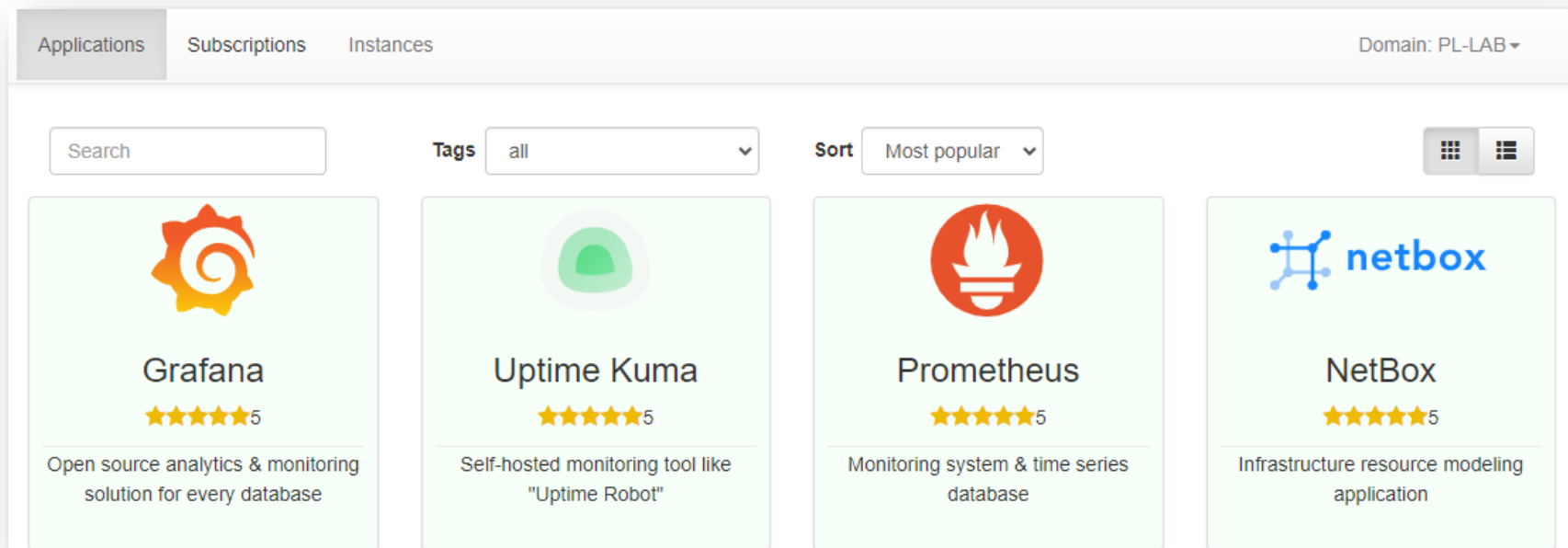
- Kubernetes-based infrastructure
- Multi-tenant architecture
- Simple application deployment and upgrade process
- Wide and easily extendable portfolio of applications
- GitOps approach for application instance configuration management
- Easy troubleshooting



Software available at <https://gitlab.software.geant.org/nmaas>

# nmaas Feature Highlights: Extensible Application Catalog

- Self-service catalog of deployable applications
- Easily extensible using the industry standard Helm package manager
  - Each application represented by a Helm chart
- Application settings can be customized during deployment or while running



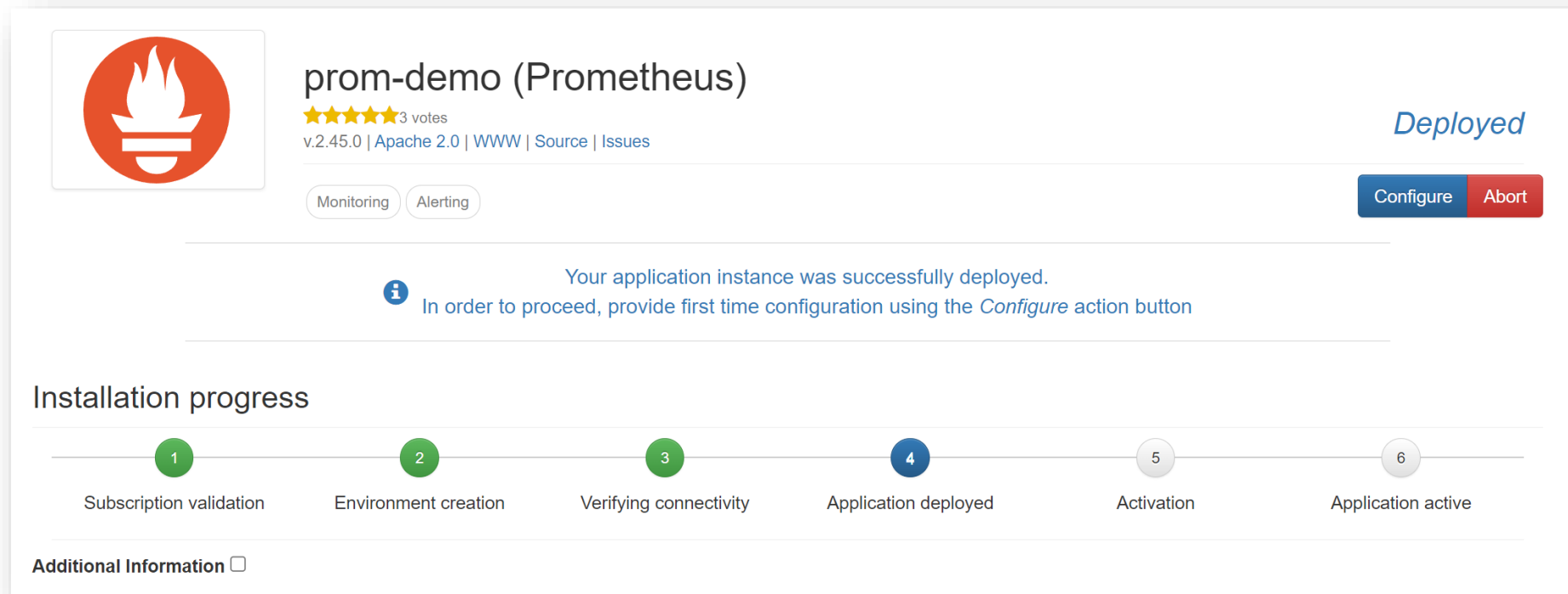
## nmaas Feature Highlights: GitOps Configuration

- Problem: Many applications use text-based configuration files. How to manage them at scale in a cloud environment?
- Solution: nmaas adopts the GitOps approach
- Workflow:
  - Configuration files placed in a private Git repository
  - User clones the repository using their credentials
  - Changes are pushed upstream
  - The altered files are synced to the running container
  - The application is reloaded/restarted
- Examples: Prometheus, Zabbix, Icinga2, Airflow



# nmaas Feature Highlights: Guided Configuration Wizard (1)

- Configuration wizard to aid initial application deployment
  - Options dependent on the application at hand
  - Possible integration with Git



The screenshot displays the configuration wizard for 'prom-demo (Prometheus)'. The application is marked as 'Deployed'. A message states: 'Your application instance was successfully deployed. In order to proceed, provide first time configuration using the *Configure* action button'. Below this is an 'Installation progress' bar with six steps: 1. Subscription validation, 2. Environment creation, 3. Verifying connectivity, 4. Application deployed (current step), 5. Activation, and 6. Application active. There are 'Configure' and 'Abort' buttons in the top right. The interface also includes a 'Monitoring' and 'Alerting' toggle, a star rating of 3 votes, and version information (v.2.45.0 | Apache 2.0 | WWW | Source | Issues). An 'Additional Information' checkbox is at the bottom left.



# nmaas Feature Highlights: Guided Configuration Wizard (2)

Detailed field descriptions are available at [NMaaS Tools Page](#).

Base Additional Advanced




**Prometheus access username \***  
demouser

**Prometheus access password \***  
....

**Global scrape**  
15s

**Global evaluation**  
30s

**Jobs \***

Job name *	Scrape interval *	Metrics path *	Targets *						
demoJob *	15s *	/metrics *	<table border="1"><thead><tr><th>IP address and port *</th><th></th></tr></thead><tbody><tr><td>127.0.0.1:9001 *</td><td></td></tr><tr><td colspan="2"><a href="#">+ Add address</a></td></tr></tbody></table>	IP address and port *		127.0.0.1:9001 *		<a href="#">+ Add address</a>	
IP address and port *									
127.0.0.1:9001 *									
<a href="#">+ Add address</a>									


[+ Add jobs](#)



[Apply configuration](#)

## nmaas Feature Highlights: Guided Configuration Wizard (2)

demo > prometheus-1496 > Repository

master prometheus-1496 / **prometheus.yml**

 Initial commit of prometheus.yml  
nmaas bot authored 2 minutes ago

 **prometheus.yml** 296 Bytes 

```
1 global:
2   scrape_interval: 15s
3   evaluation_interval: 30s
4 alerting:
5   alertmanagers:
6     - static_configs:
7       - targets:
8 rule_files:
9 scrape_configs:
10  - job_name: 'demoJob'
11    metrics_path: /metrics
12    scrape_interval: 15s
13    static_configs:
14  - targets: ['127.0.0.1:9001']
15    labels:
```



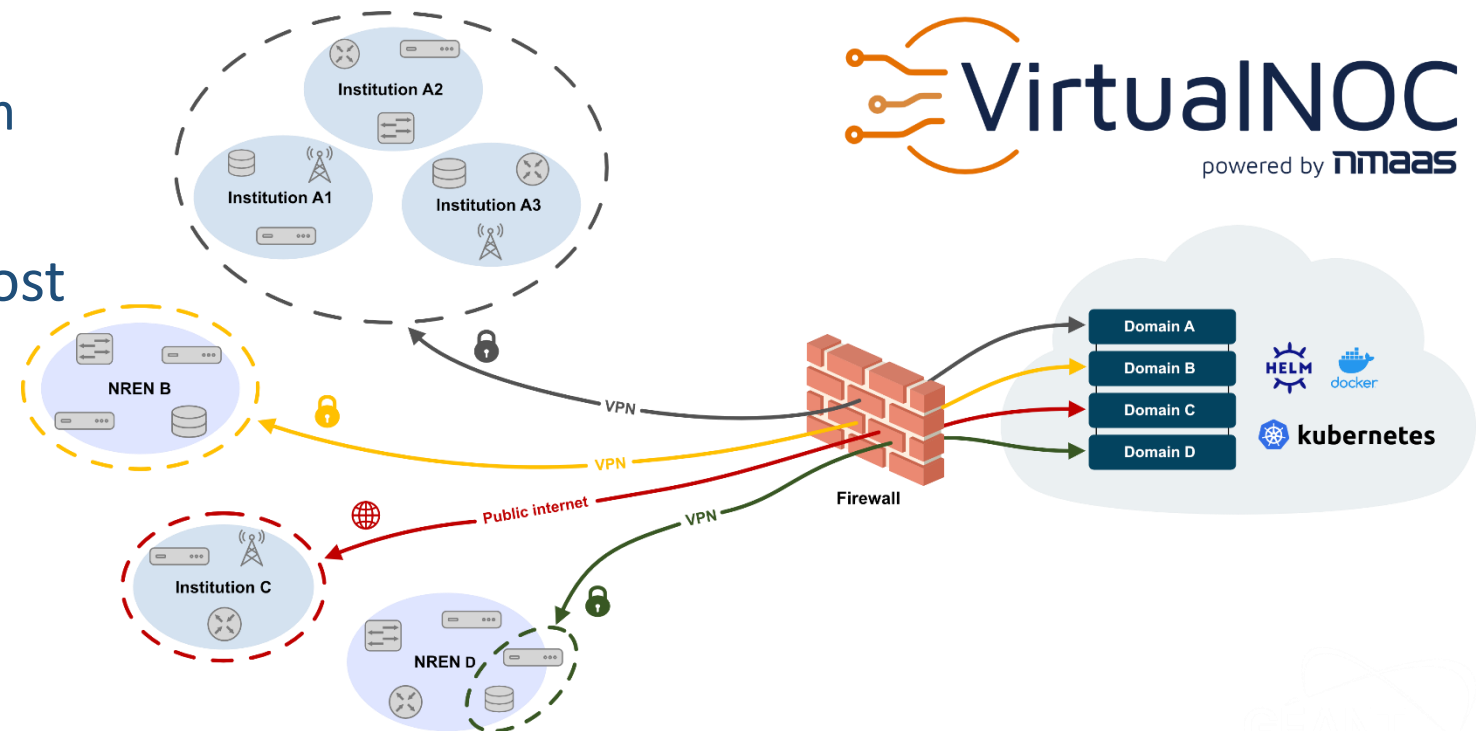


# nmaas for Virtual NOC (vNOC)

New name for NMaaS (Network Management as a Service)

# nmaas for Virtual NOC

- Versatility of nmaas as an open-source orchestration platform
- Support for multiple use-cases
- NMaaS (Network Management as a Service) as the initial use-case
- Rebranding
  - nmaas – the underlying platform
  - nmaas for Virtual NOC
- Application catalog containing most popular network management applications
- Continuous improvement



# nmaas for Virtual NOC: Target Groups and Usage Models

- Target groups
  - NRENs or end institutions with limited capacity for in-house network management
    - Universities, high schools, primary schools
  - International research projects with (distributed) hardware resources
  - Development/infrastructure teams requiring external health monitoring and alerting for their applications
- Can be used either as a self-hosted or managed solution
  - Self-hosting requirement: Kubernetes cluster
  - <https://nmaas.eu> is the managed production instance for the Virtual NOC use-case

# nmaas for Virtual NOC: Recent Developments



- Manual/Automatic application version upgrades
- Overview of application instance deployment parameters
- **Application log viewing**

Pod  
prometheus-1496-949fbc67f-zgwsw

Container  
nmaas-prometheus-srv

Refresh

Download

```

ts=2024-05-21T11:40:19.392Z caller=main.go:584 level=info host_details="(Linux 4.15.0-213-generic #224-Ubuntu SMP Mon Jun 19 13:30:12 UTC 2023 x86_64 tinkr-lab-prometheus-1496-949fbc67f-zgwsw (none))"
ts=2024-05-21T11:40:19.392Z caller=main.go:585 level=info fd_limits="(soft=1048576, hard=1048576)"
ts=2024-05-21T11:40:19.392Z caller=main.go:586 level=info vm_limits="(soft=unlimited, hard=unlimited)"
ts=2024-05-21T11:40:19.409Z caller=web.go:562 level=info component=web msg="Start listening for connections" address=0.0.0.0:9090
ts=2024-05-21T11:40:19.410Z caller=main.go:1019 level=info msg="Starting TSDB ..."
ts=2024-05-21T11:40:19.415Z caller=ts_config.go:274 level=info component=web msg="Listening on" address=[:]:9090
ts=2024-05-21T11:40:19.415Z caller=ts_config.go:277 level=info component=web msg="TLS is disabled." http2=false address=[:]:9090
ts=2024-05-21T11:40:19.443Z caller=head.go:595 level=info component=tsdb msg="Replaying on-disk memory mappable chunks if any"
ts=2024-05-21T11:40:19.443Z caller=head.go:676 level=info component=tsdb msg="On-disk memory mappable chunks replay completed" duration=5.97µs
ts=2024-05-21T11:40:19.443Z caller=head.go:684 level=info component=tsdb msg="Replaying WAL, this may take a while"
ts=2024-05-21T11:40:19.444Z caller=head.go:755 level=info component=tsdb msg="WAL segment loaded" segment=0 maxSegment=0
ts=2024-05-21T11:40:19.444Z caller=head.go:792 level=info component=tsdb msg="WAL replay completed" checkpoint_replay_duration=110.077µs
wal_replay_duration=635.248µs wbl_replay_duration=376ns total_replay_duration=817.88µs
ts=2024-05-21T11:40:19.446Z caller=main.go:1040 level=info fs_type=EXT4_SUPER_MAGIC
ts=2024-05-21T11:40:19.447Z caller=main.go:1043 level=info msg="TSDB started"
ts=2024-05-21T11:40:19.447Z caller=main.go:1224 level=info msg="Loading configuration file" filename=/etc/config/prometheus.yml
ts=2024-05-21T11:40:19.448Z caller=main.go:1261 level=info msg="Completed loading of configuration file" filename=/etc/config/prometheus.yml totalDuration=1.268875ms
db_storage=1.986µs remote_storage=3.372µs web_handler=874ns query_engine=1.733µs scrape=480.089µs scrape_sd=41.982µs notify=41.456µs notify_sd=15.318µs
rules=2.323µs tracing=10.567µs
ts=2024-05-21T11:40:19.448Z caller=main.go:1004 level=info msg="Server is ready to receive web requests."
ts=2024-05-21T11:40:19.448Z caller=manager.go:995 level=info component="rule manager" msg="Starting rule manager..."

```



# nmaas for Virtual Lab (vLab)

A new use-case for the nmaas Platform

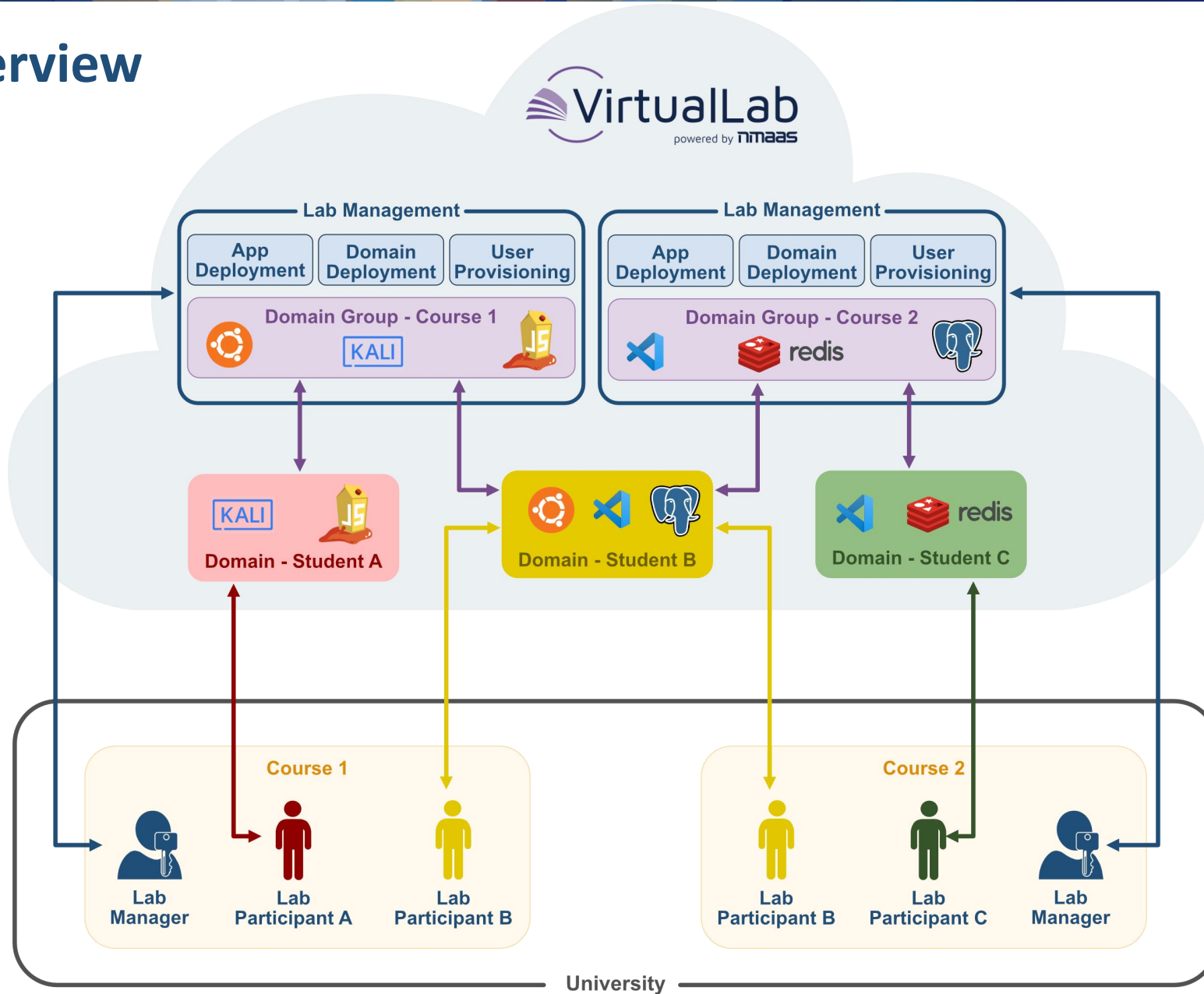


## nmaas for Virtual Labs in a Nutshell

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



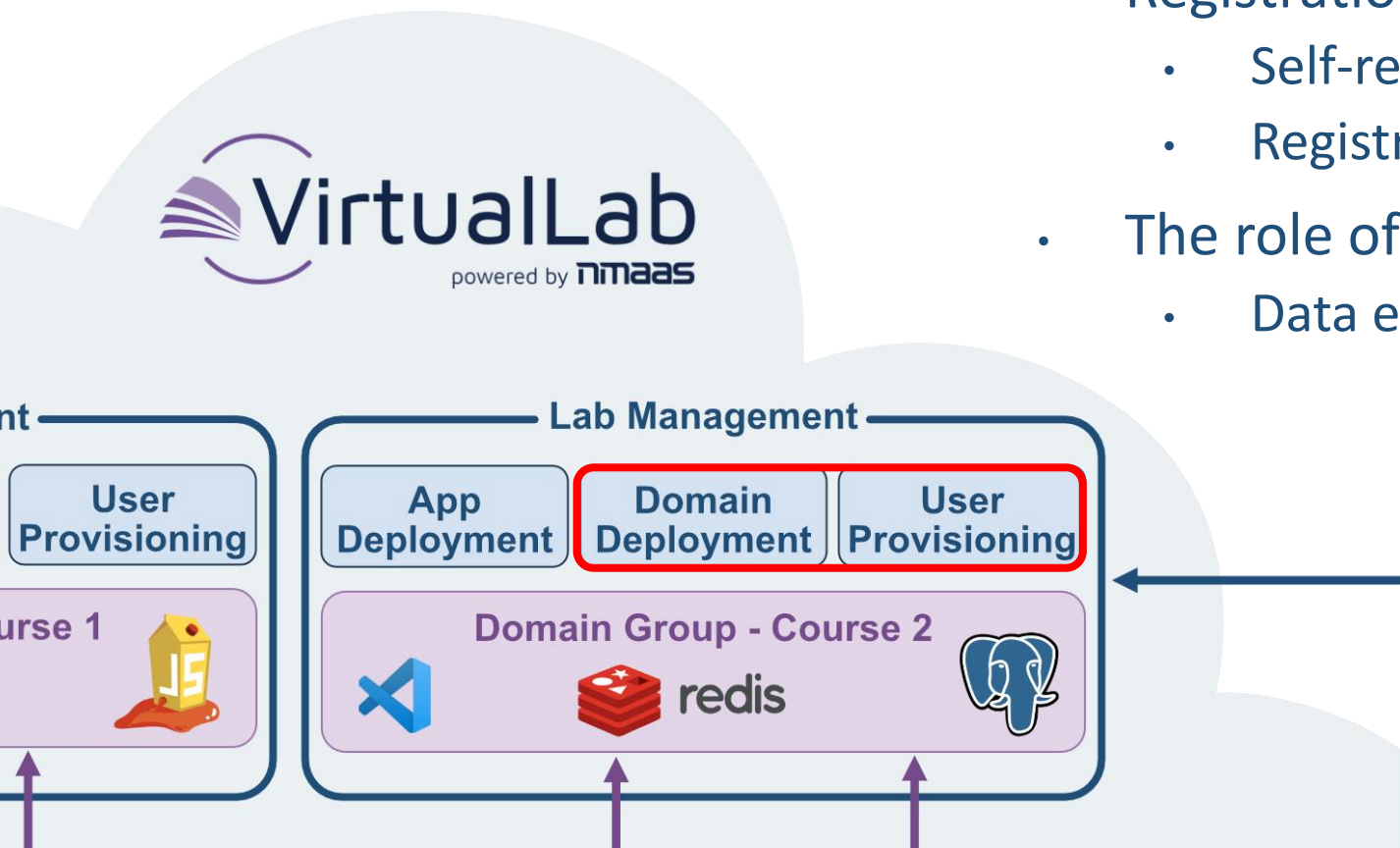
# Concept Overview





# User Provisioning

- Requirements for a new lab participant:
  - User account
  - Dedicated nmaas domain
- Registration options:
  - Self-registration by the lab participant
  - Registration in bulk by the lab manager
- The role of learning management systems (LMS)
  - Data export and import



**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.

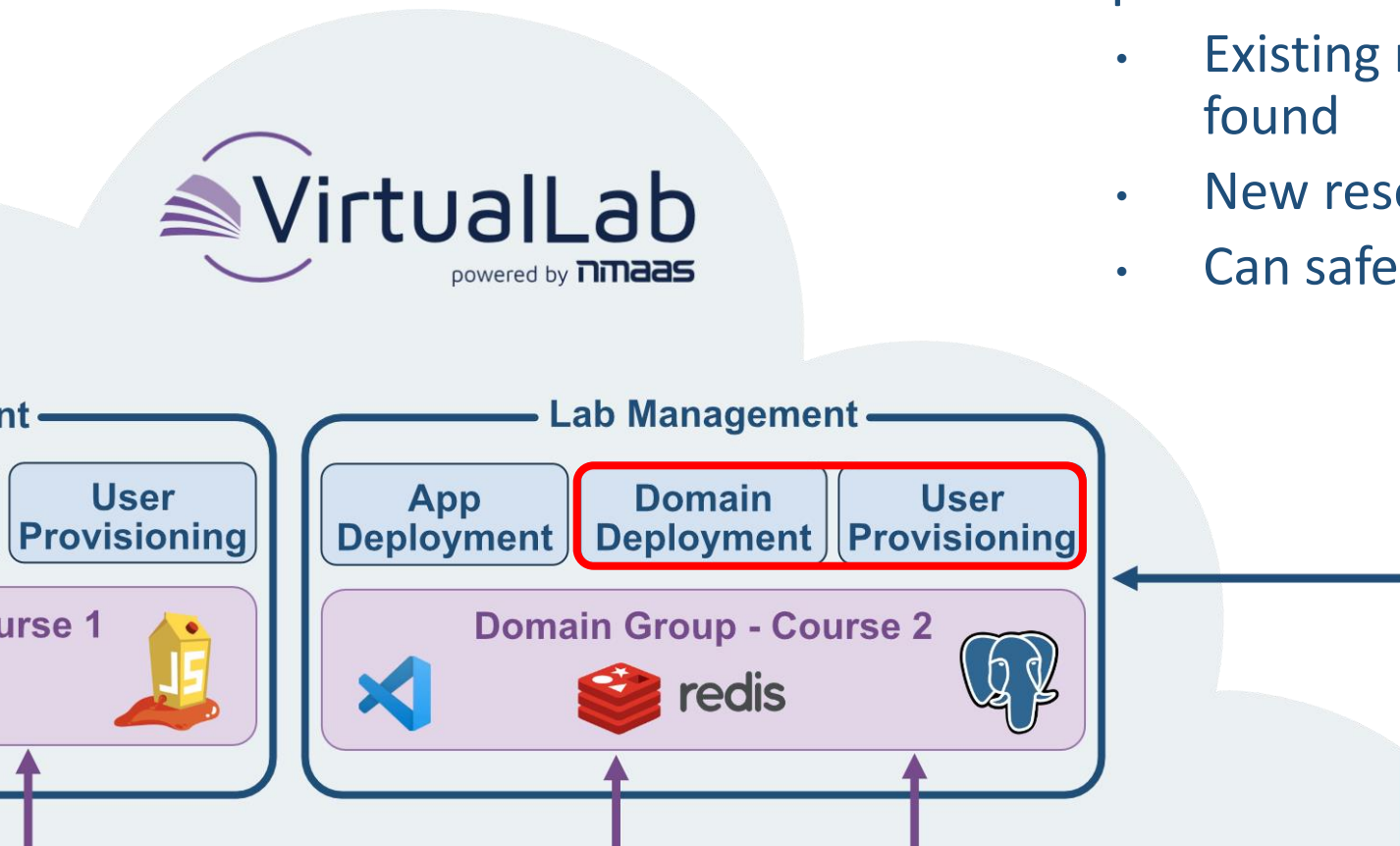


### Target users

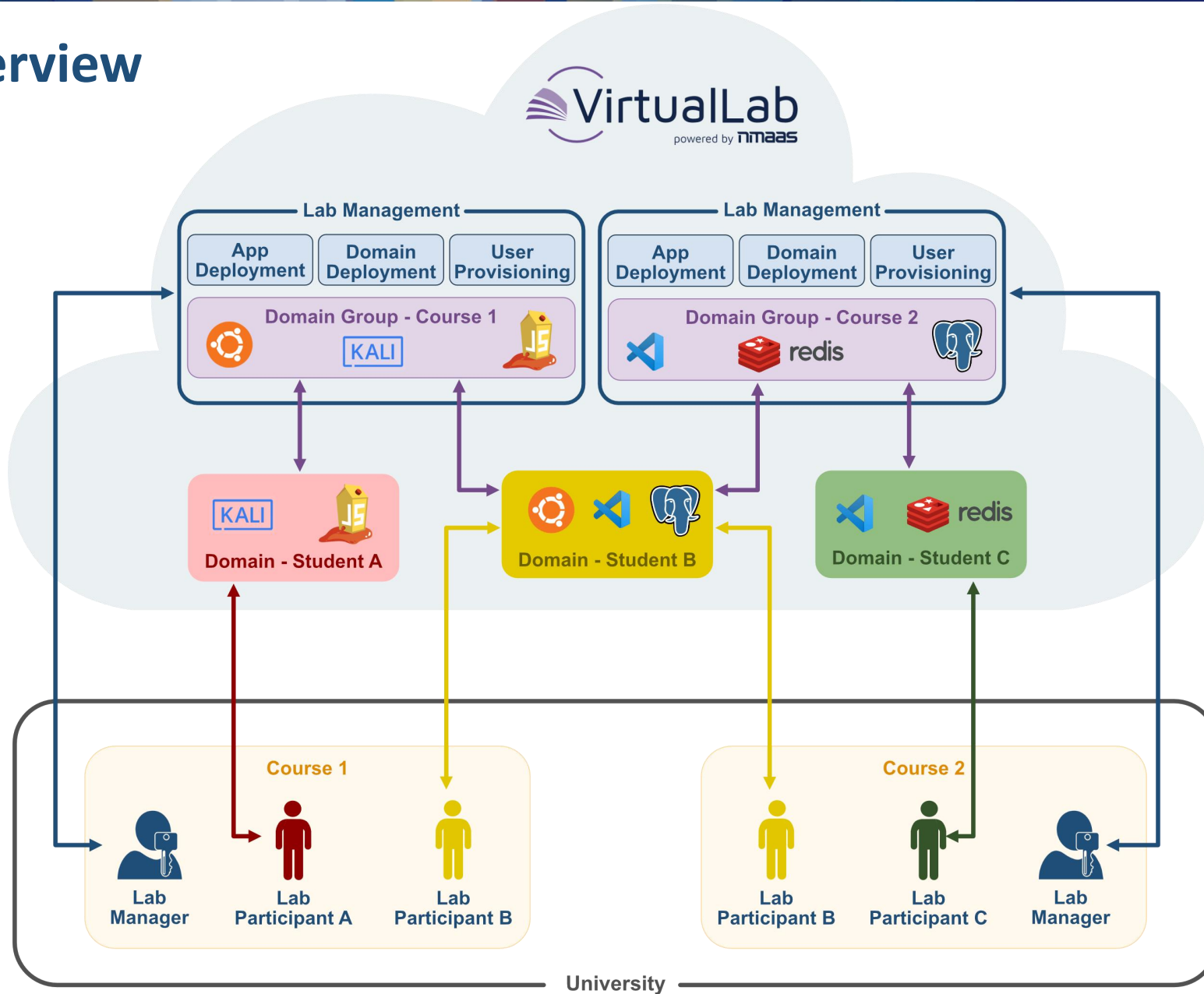
NMaaS users are organisations that do not want to own NMS infrastructure themselves and/or want to outsource network management, as well as organisations and/or individuals that are searching for quality network management software or who want to

## User Provisioning – Key Takeaways

- Multiple lab managers using a single nmaas deployment
- User and domain creation is an idempotent operation
  - Existing resources are reused when a match is found
  - New resources are created only when required
  - Can safely be repeated multiple times

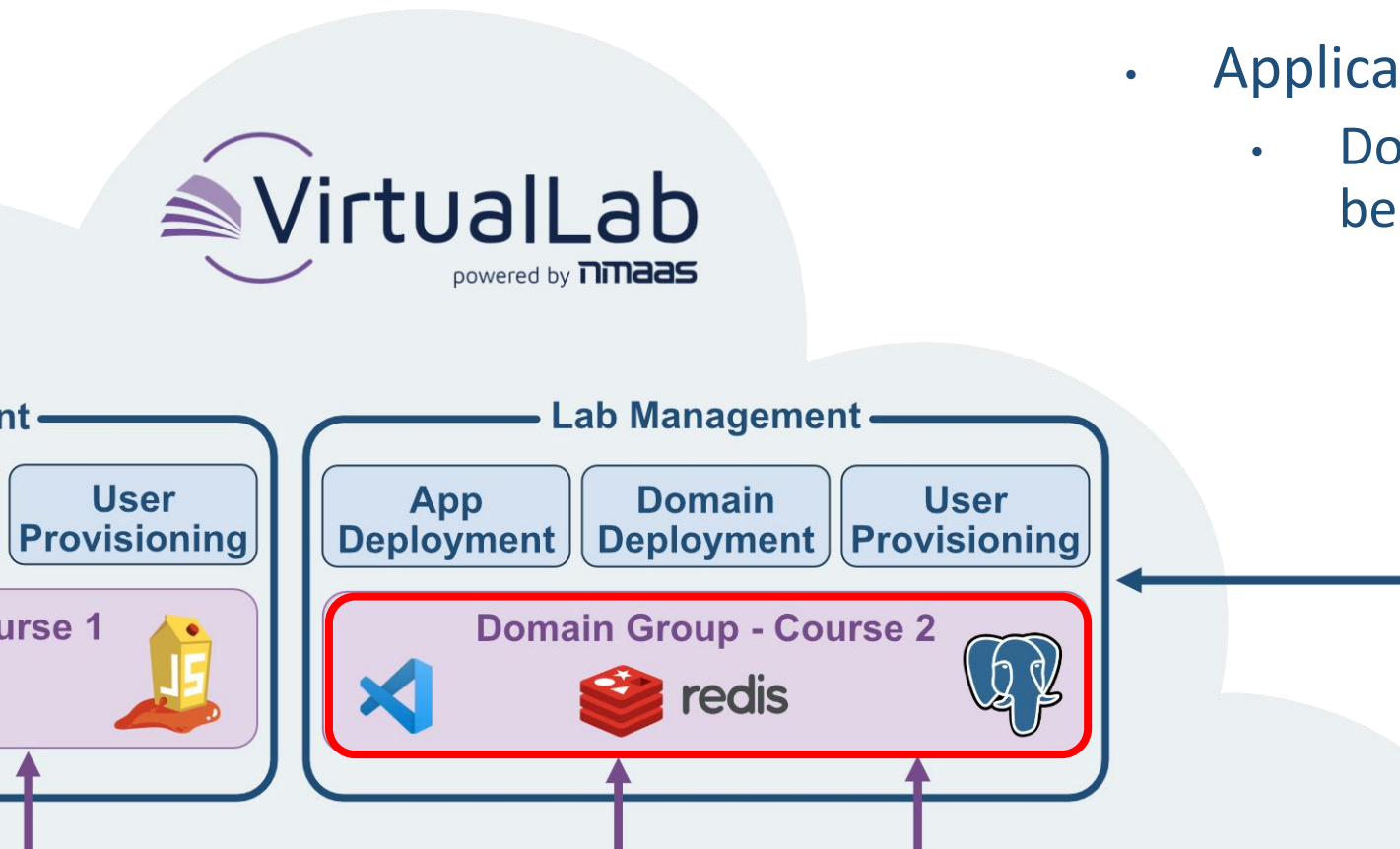


# Concept Overview



# Domain Groups

- Domain groups – core new nmaas concept in dedicated to virtual labs
- Enables the use of a single nmaas instance across multiple courses and/or institutions
- Application whitelisting
  - Domain groups specify which applications can be deployed by participating domains





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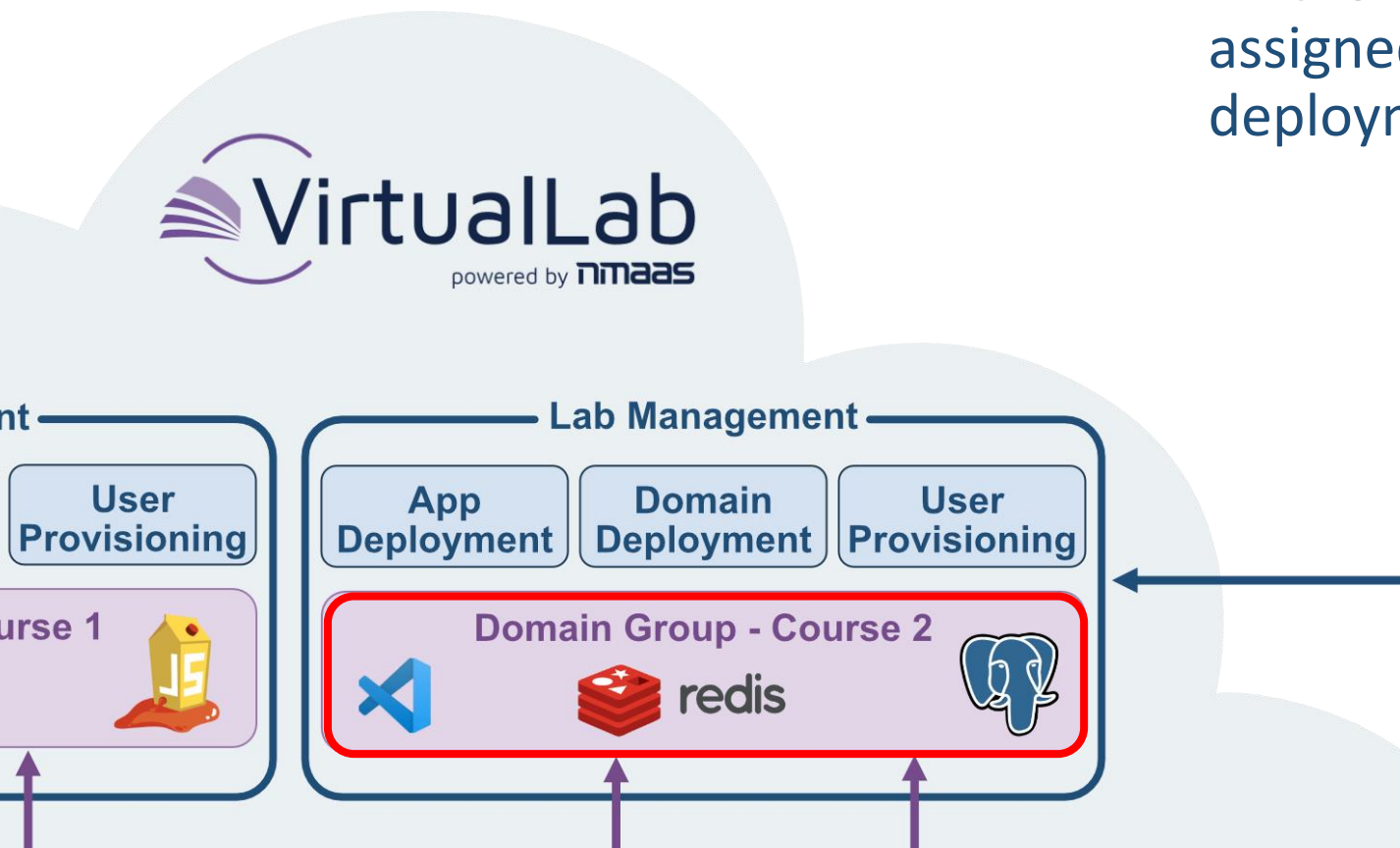


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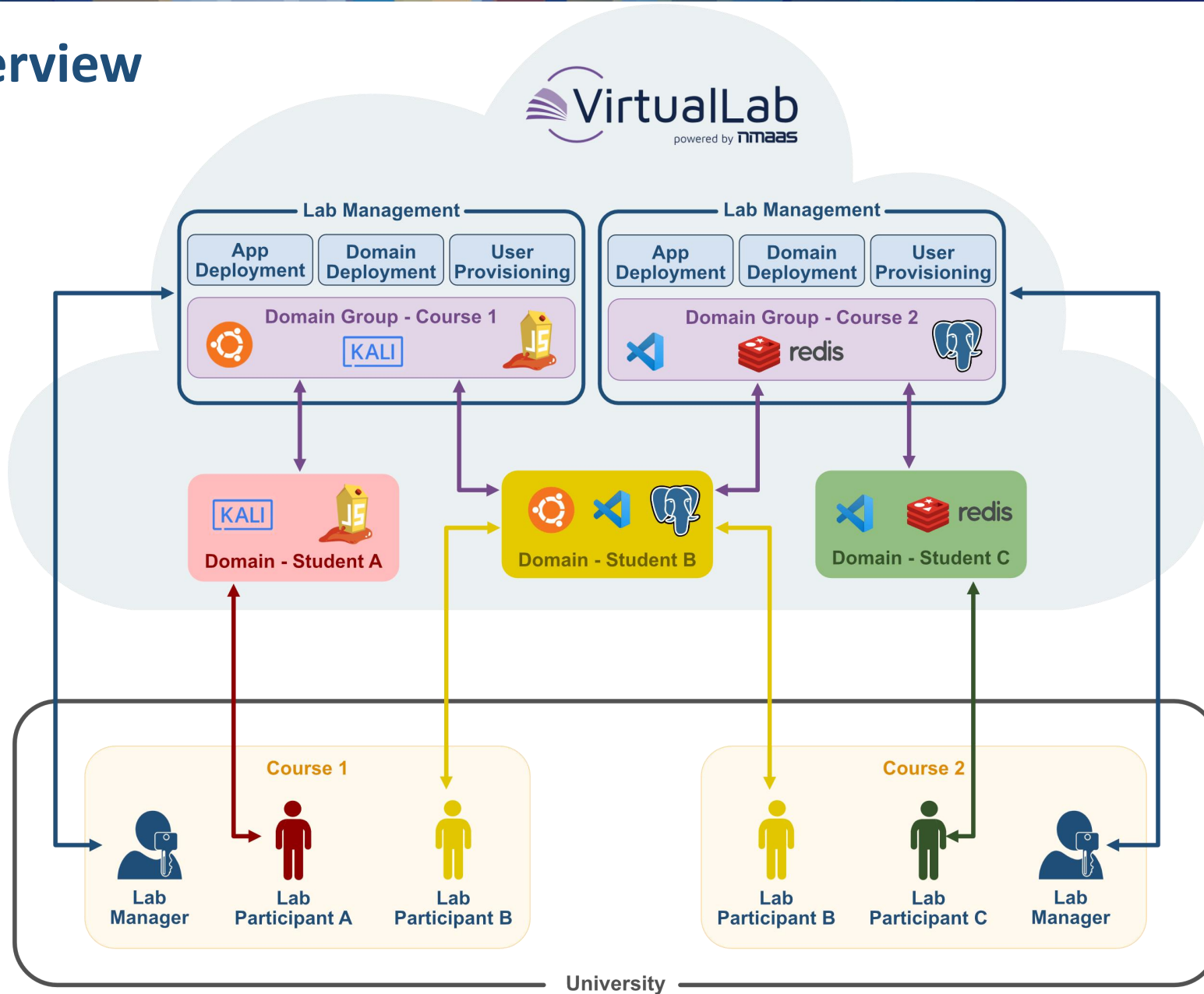
## Domain Groups – Key Takeaways

- A domain can be part of multiple domain groups
  - A student participating in multiple courses
- All the whitelisted applications across the assigned domain groups are available for deployment



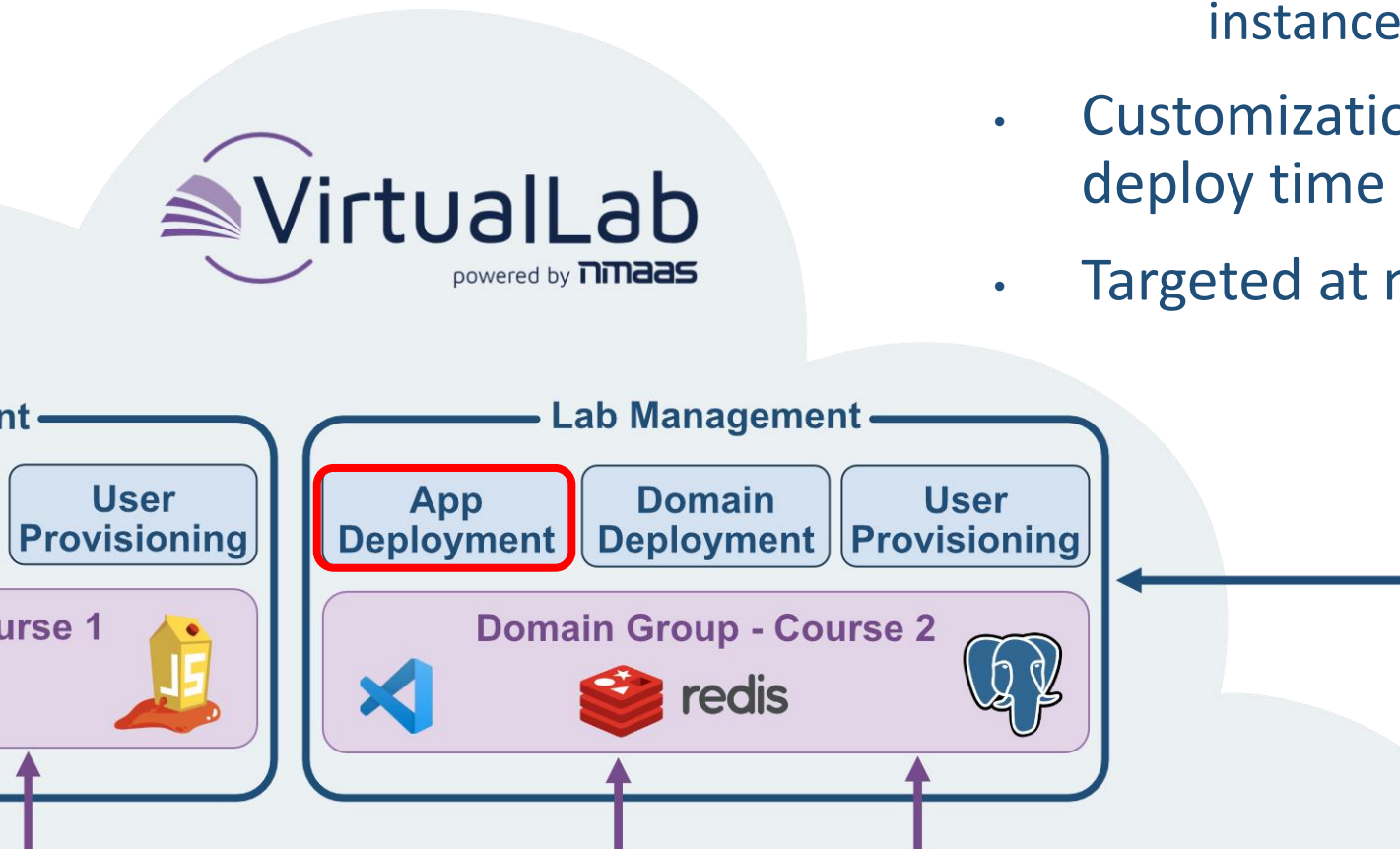


# Concept Overview



# Application Deployments by Lab Participants

- Application deployment options:
  - Individual, each lab participants deploys and configures their own instance
  - In bulk, a lab manager deploys preconfigured instances
- Customization of application parameters during deploy time
- Targeted at more experienced lab participants



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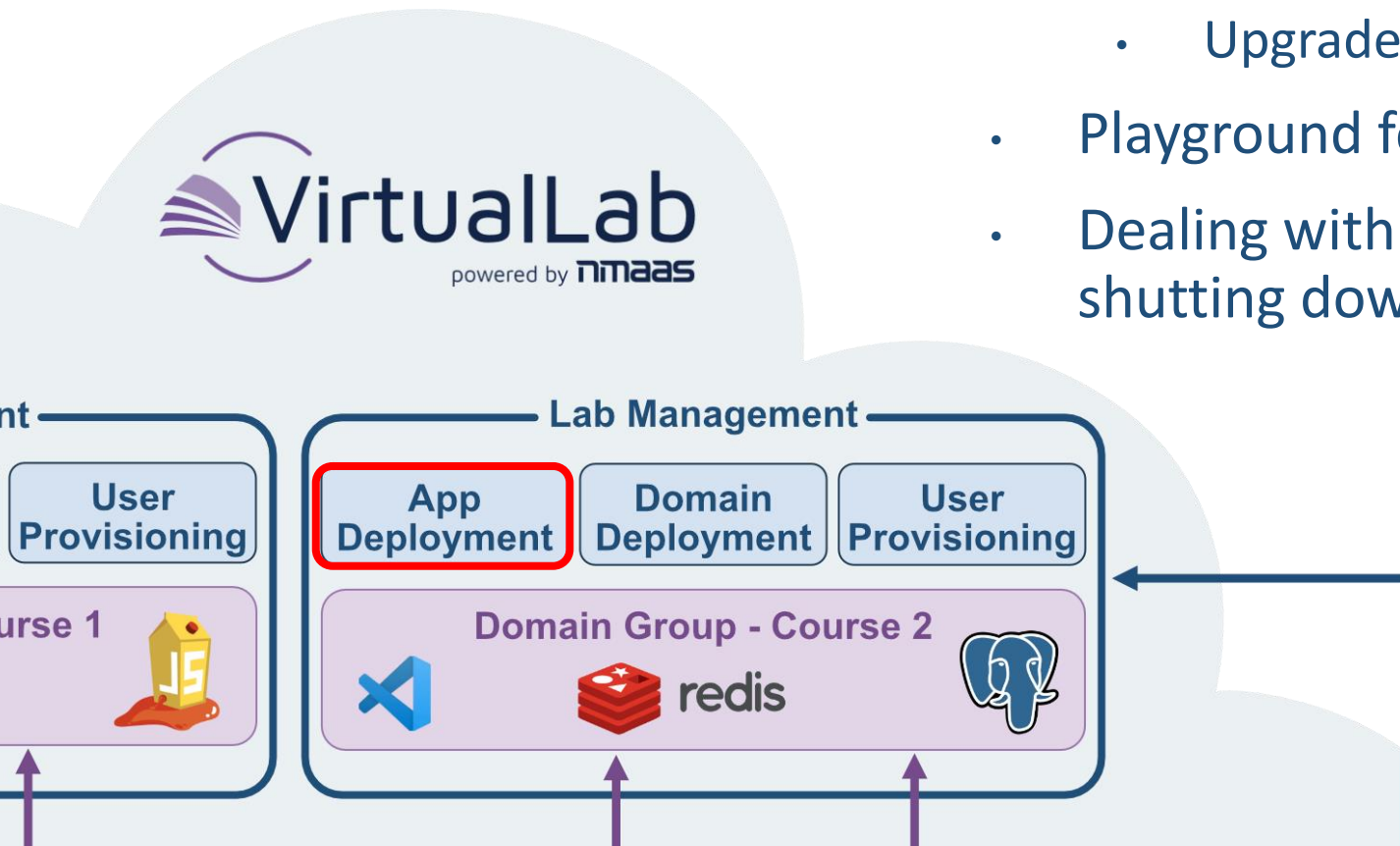


### Target users

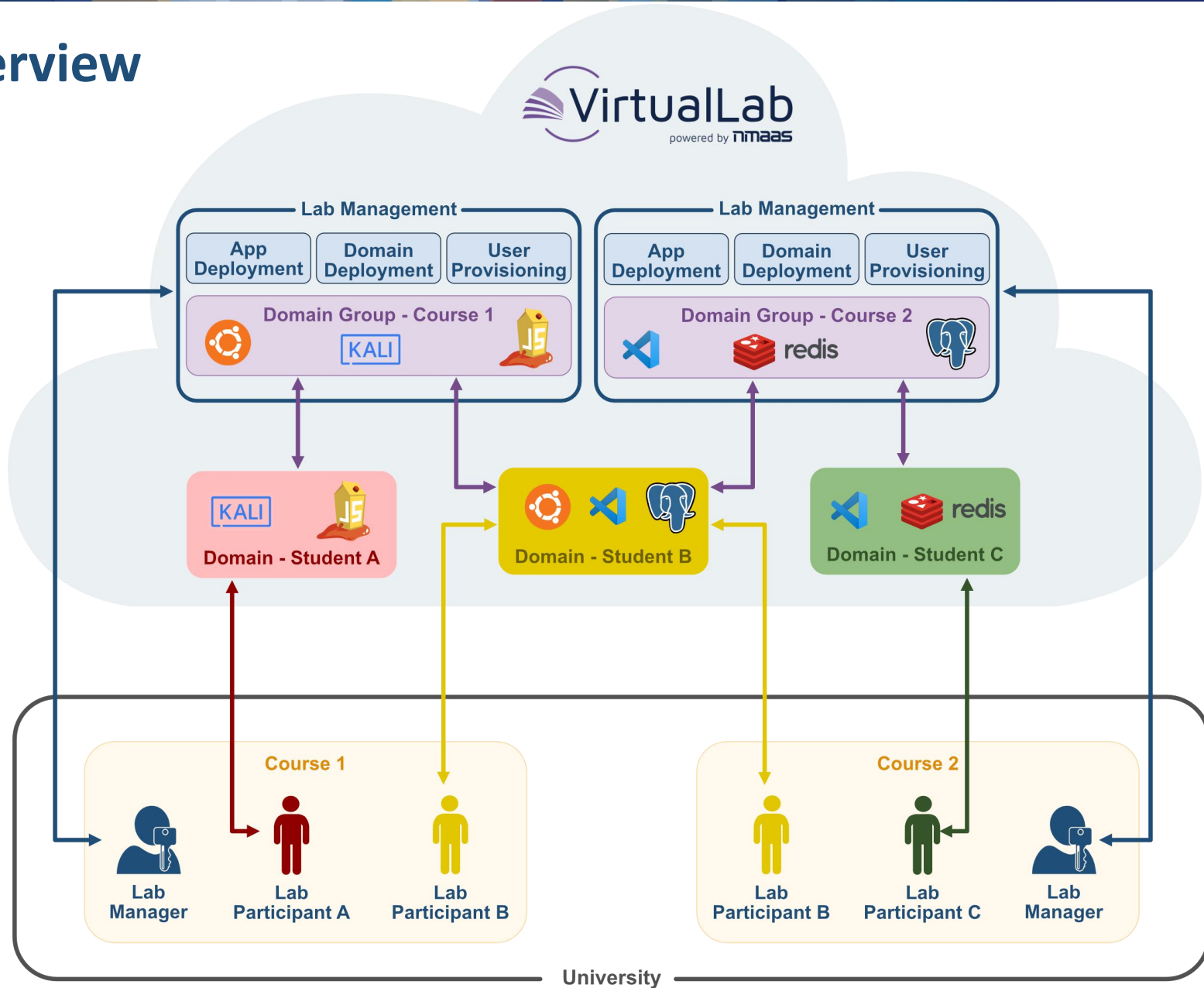
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## Application Deployments by Lab Participants – Key Takeaways

- Lab participants have full control over the lifecycle of their application instance
  - Deployment
  - Removal
  - Upgrades
- Playground for exploring additional applications
- Dealing with large number of lab participants by shutting down idle instances



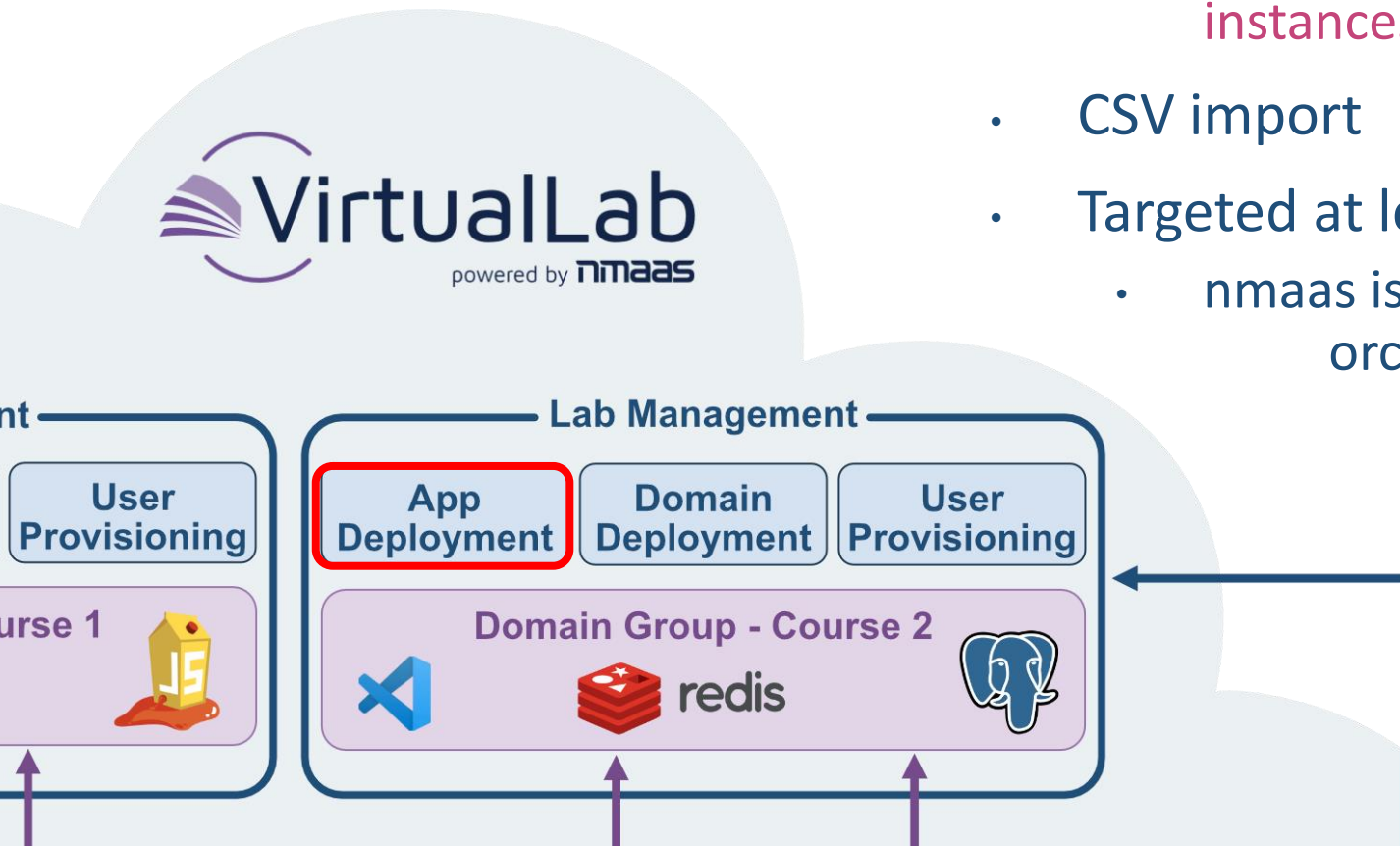
# Concept Overview





# Bulk Application Deployments by Lab Managers

- Application deployment options:
  - Individual, each lab participants deploys and configures their own instance
  - **In bulk, a lab manager deploys preconfigured instances**
- CSV import
- Targeted at less experienced lab participants
  - nmaas is transparent and used solely as an orchestration tool



# Network Management as a Service (NMaaS)

provides a portfolio of network management applications run as dedicated per-user instances in the cloud.

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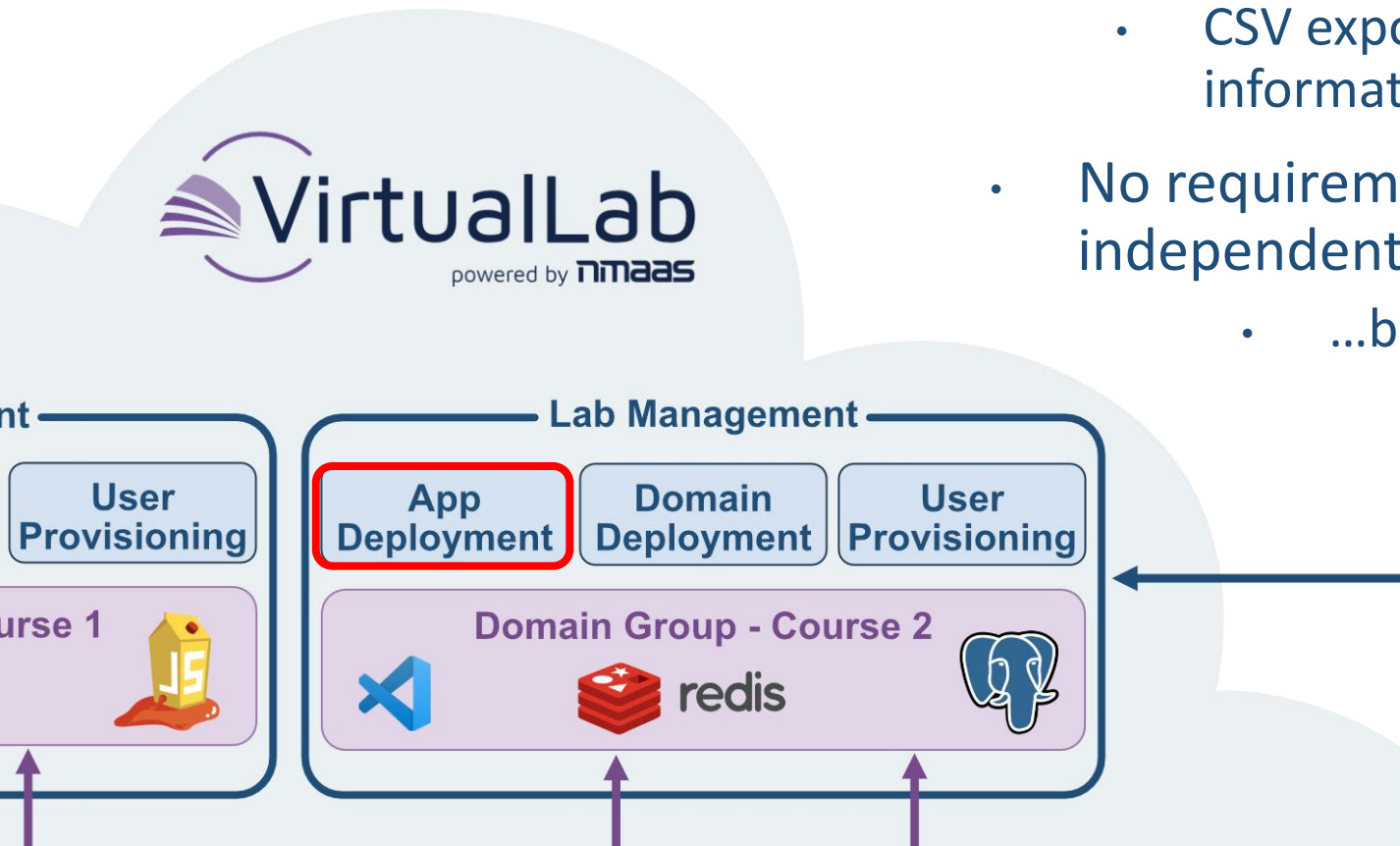
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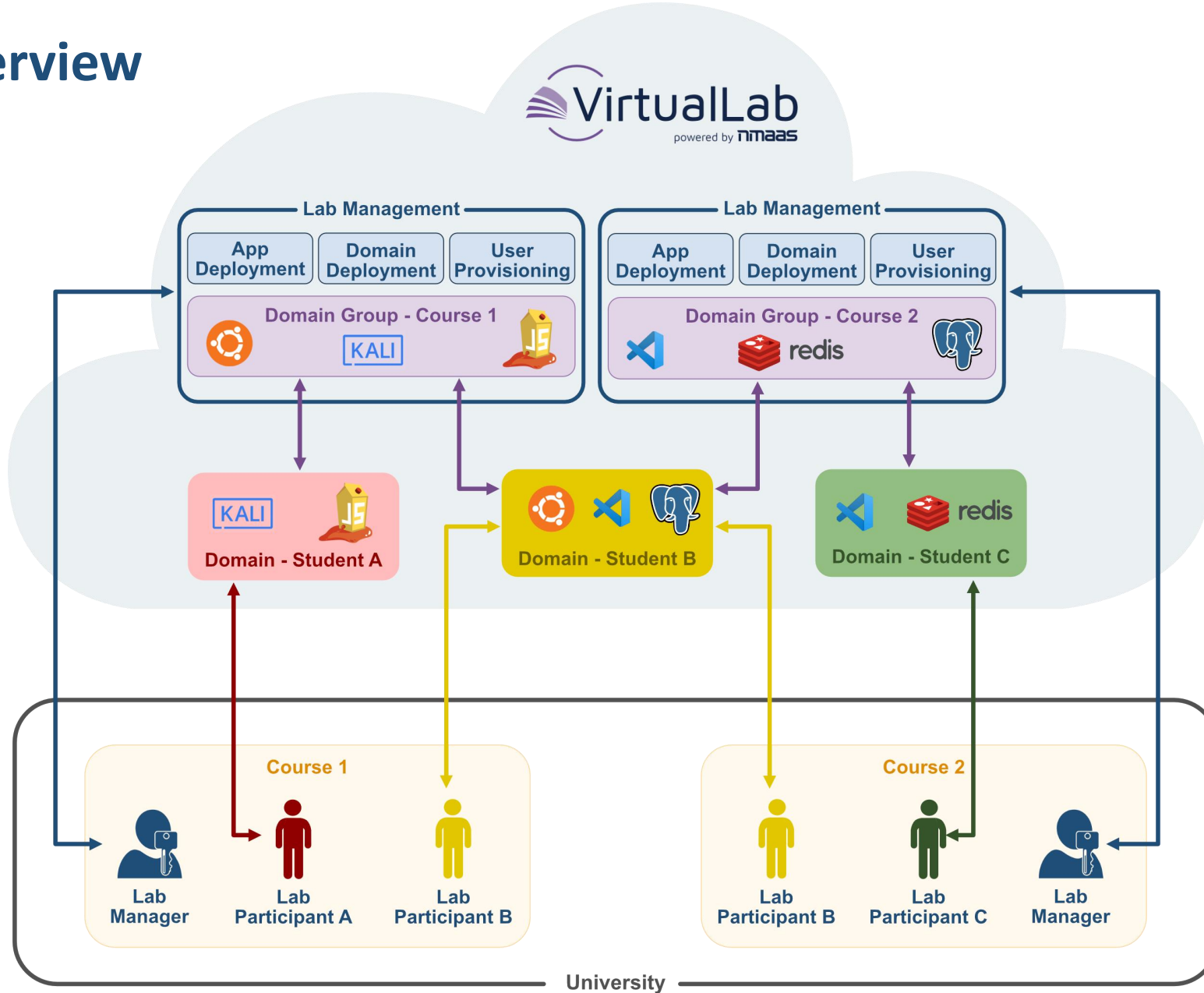


## Bulk Application Deployments by Lab Managers – Key Takeaways

- Multiple options for sharing application instance information:
  - Email with a direct access link sent to the lab participant
  - CSV export by the lab manager and sharing the information using a different platform, e.g. LMS
- No requirement for application instances to be in independent domains
  - ...but a recommended practice



# Concept Overview



## nmaas for Virtual Labs in Practice

- Two pilots at the Ss. Cyril and Methodius University in Skopje, North Macedonia
- Ethical hacking course
  - Capture the Flag competition
  - Deployment of a purposefully vulnerable application by the lab participants themselves
  - Flags exchanged for points towards a final grade
  - Scaling down of inactive instances
- IT Service Management Course
  - Deployment of a ticketing system instance per lab participant
  - Long lived applications throughout the semester
  - Applications deployed in bulk by lab managers and access details shared with lab participants
- Feedback loops for additional features and improvements

## Using nmaas for Virtual Labs

- Dedicated playground instance for virtual lab pilots at <https://vlab.dev.nmaas.eu>
- Open to the community to evaluate the new features and perform small-scale, real-world trials
- Self-hosted deployment recommended for large-scale use
- Documentation available at <https://vlab.docs.nmaas.eu>







# Conclusion

## The Road Ahead

- Discovering additional use-cases
- Improvements to vNOC:
  - Application bundles
  - VPN provisioning
  - Improvements to domain provisioning
- Improvements to vLab:
  - Unattended on-boarding
  - Extending the portfolio of supported scenarios
  - Collaboration with e-Academy





# Thank You

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