How to orchestrate services in the EOSC Compute Platform with the INDIGO PaaS

Marica Antonacci, Giacinto Donvito
INFN - National Institute for Nuclear Physics (Italy)

EGI Webinar

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Outline

- INDIGO PaaS Overview
- What is TOSCA
- Orchestrator high level architecture
- PaaS main features
- User interfaces
- Live demo

INDIGO PaaS origins

The development of the INDIGO PaaS started during the **European H2020 project** "**INDIGO-DataCloud**" aimed to develop an open source Cloud platform for computing and data ("DataCloud") tailored to science but applicable to other domains as well

- 26 partners coordinated by INFN (11.1M€, 30 months - April 2015 to September 2017)

and continued during the two spin-off projects DEEP-Hybrid DataCloud, eXtreme-DataCloud and EOSC-Hub (2017-2020)

- Evolving the functionalities to **TRL8**
- Ensuring the scalability and performance of the developed solutions
- Providing relevant contributions to the **European Open Science Cloud**

Current exploitation and usage

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Several on-going projects rely on the INDIGO PaaS as federation and orchestration tool: EGI-ACE, C-SCALE, IoTwins, ...

It is also used in production services like

- **Laniakea@ReCaS**, the service that allows to perform the automatic deployment of virtual Galaxy environments for life science (Elixir-Italy)
- **DODAS (Dynamic On Demand Analysis Service)**, a service for generating an on-demand container-based HTCondor cluster
- The **INFN Cloud Infrastructure** is exploiting the INDIGO PaaS capabilities for federating the resources provided by the two large data centers of CNAF and Bari, and other satellite sites.

Foundations and key enablers

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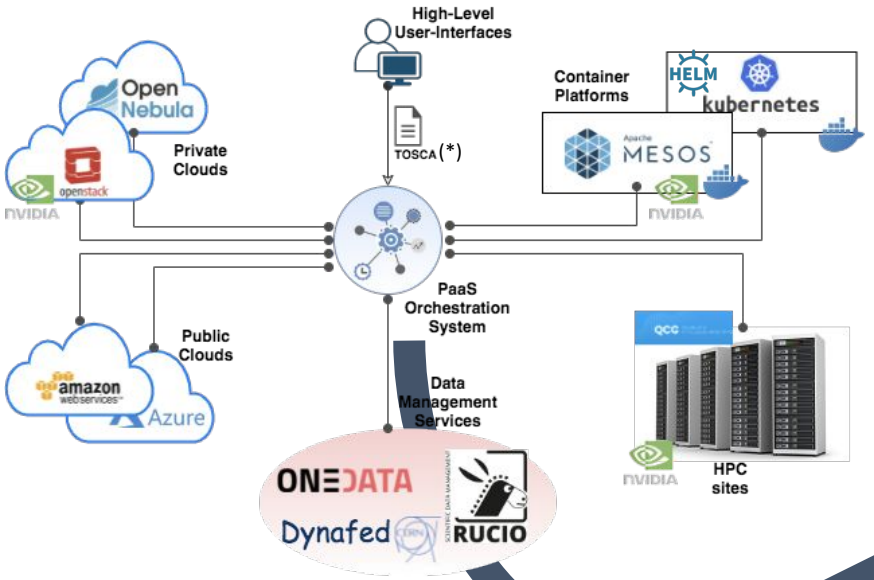
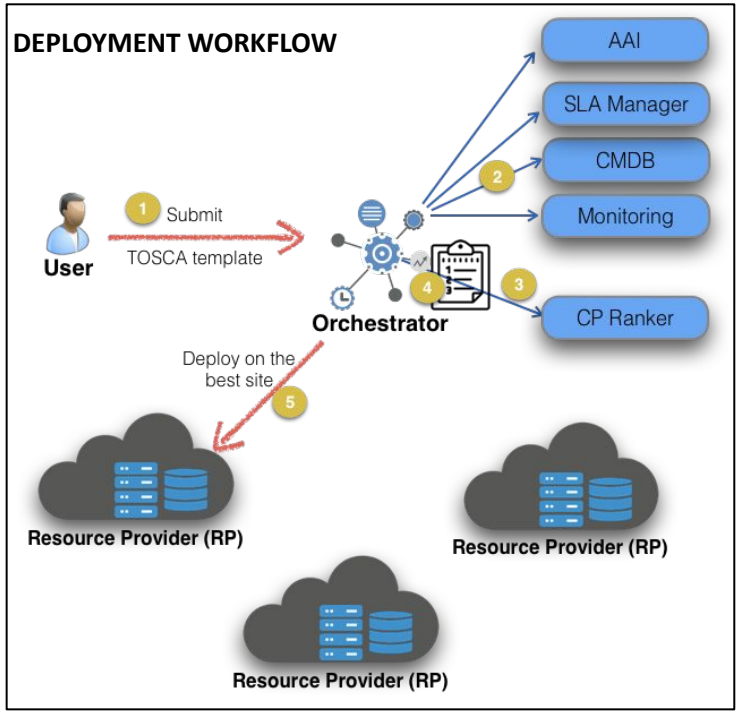
- Develop and integrate **open-source** and **open standard-based** components to ensure portability and interoperability
- Adopt a **modular micro-service** architecture
- Use **Infrastructure as Code** (IaC), DevOps and **containers** to reduce manual processes and increase flexibility and portability across environments
- Leverage **federated Authentication and Authorization** technologies based on **OpenID-Connect** (supporting also legacy AAI solutions) like **INDIGO-IAM** and EGI Check-in
- Enable flexible **service composition** and re-use

INDIGO PaaS Orchestration System
High-level architecture





(*) Topology and Orchestration Specification for Cloud Applications Ref: TOSCA Simple Profile in YAML Version 1.1

The Orchestrator interacts with the provider services through:

- the **Infrastructure Manager** for deploying complex and customized virtual infrastructures on multiple IaaS Cloud backends (Openstack, AWS, etc.)
- direct APIs for deploying dockerized workloads on container platforms or submitting HPC jobs

TOSCA

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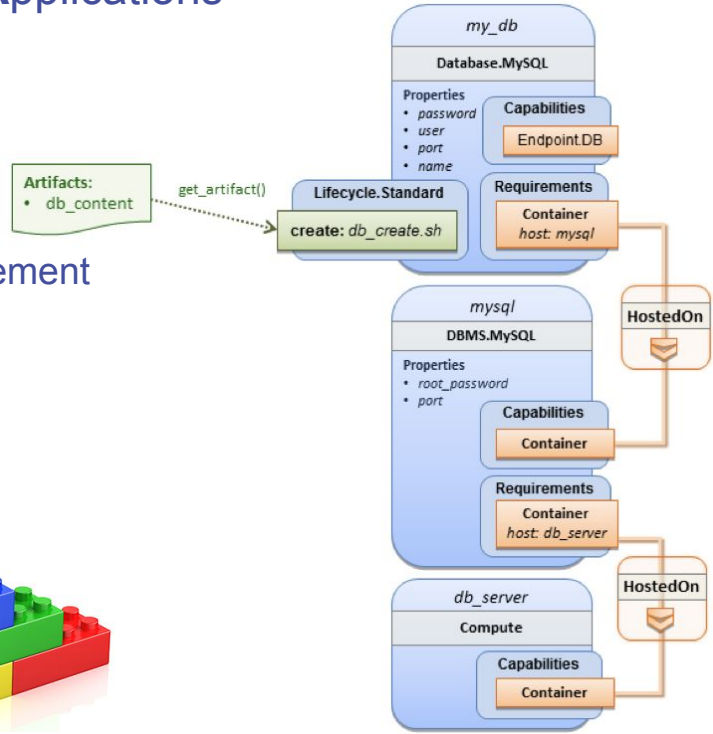
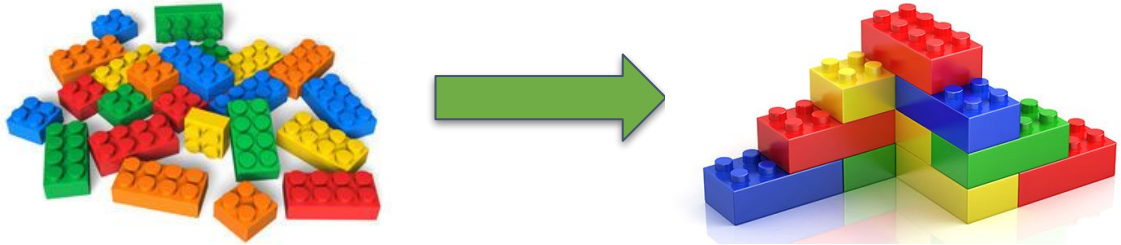
Topology and **O**rchestration **S**pecification for **C**loud **A**pplications

- Goals:
  - Automated Application Deployment and Management
  - Portability of Application Descriptions and Their Management
  - Interoperability and Reusability of Components





Ref: TOSCA Simple Profile in YAML Version 1.1

Template examples

```
tosca_definitions_version: tosca_simple_yaml_1_0_0

description: Template for deploying a single server with predefined properties.

topology_template:
  inputs:
    cpus:
      type: integer
      description: Number of CPUs for the server.
      constraints:
        - valid_values: [ 1, 2, 4, 8 ]

  node_templates:
    my_server:
      type: tosca.nodes.Compute
      capabilities:
        # Host container properties
        host:
          properties:
            # Compute properties
            num_cpus: { get_input: cpus }
            mem_size: 4 MB
            disk_size: 10 GB

  outputs:
    server_ip:
      description: The private IP address of the provisioned server.
      value: { get_attribute: [ my_server, private_address ] }
```

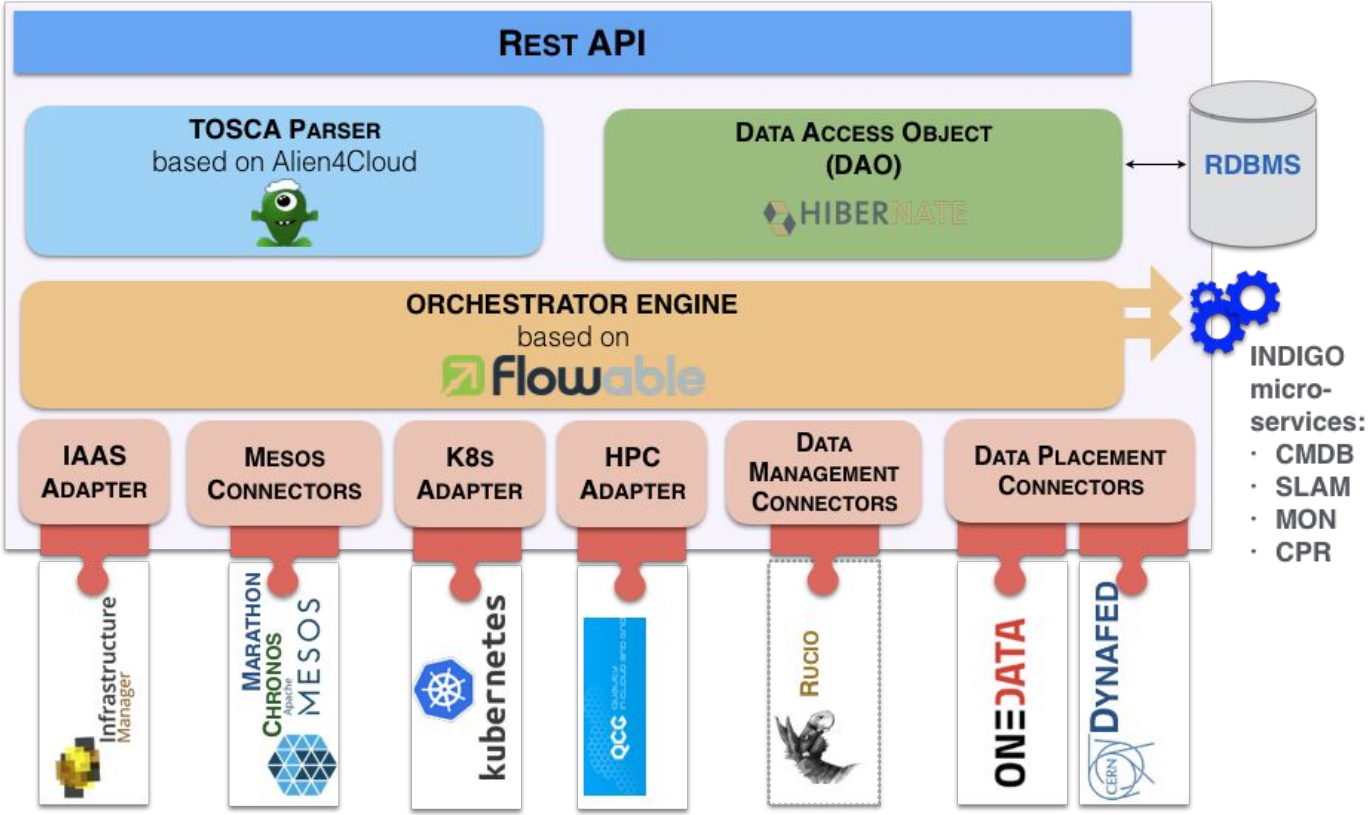
```
tosca_definitions_version: tosca_simple_yaml_1_0_0
description: Template for deploying a single server with MySQL software on top.

topology_template:
  inputs:
    # omitted here for brevity

  node_templates:
    mysql:
      type: tosca.nodes.DBMS.MySQL
      properties:
        root_password: { get_input: my_mysql_rootpw }
        port: { get_input: my_mysql_port }
      requirements:
        - host: db_server

    db_server:
      type: tosca.nodes.Compute
      capabilities:
        # omitted here for brevity
```

PaaS Orchestrator high-level architecture



INDIGO PaaS - Main features

- **Enabling the federation of distributed and heterogeneous compute environments: clouds, docker orchestration platforms, HPC systems**
  - Further integrations can be easily included implementing new plugins (adapters)
- **Smart scheduling → Automatic selection of the provider**
  - First level based on the deployment type (cloud, Mesos, Kubernetes, HPC)
  - Second level based on SLAs and compute/storage requirements vs provider capabilities
    - Support for specialized hardware (GPU, Infiniband)
    - Data location
  - Best provider selection based on:
    - Resource quotas (SLA)
    - Monitoring data
  - Automatic retry of failed deployments
- **Support for hybrid deployments and network orchestration**
- **Client interfaces for advanced users** (REST APIs, CLI, python bindings) **and end-users** (web dashboard - no skills required)

Supported TOSCA types and templates

The INDIGO PaaS Orchestrator supports **TOSCA Simple Profile in YAML** (version 1.0)

Custom types have been developed during the INDIGO/DEEP/XDC/EOSC-Hub/… projects and are available on github: https://github.com/indigo-dc/tosca-types

Artifacts are mainly **ansible roles** and **docker images**.

Specific custom types have been implemented for modeling

- dockerized services/jobs to be deployed on Mesos clusters
- HPC jobs to be submitted through QCG Gateways
- Helm charts to be installed on Kubernetes clusters

Ready-to-use templates:

From simple to complex:

- Virtual machine provisioning (with or without additional block storage)
- Docker-based use-cases
- Cluster-based use-cases (Mesos, K8s, Spark, Galaxy)
- Applications (SaaS): Rstudio, Jupyter, Tensorflow, etc.

New services (i.e. TOSCA templates) can be easily implemented and included in the service catalogue

Orchestrator APIs

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- **Create a deployment**:
  - POST request to /deployments - parameters:
    - template: string containing a TOSCA YAML-formatted template
    - parameters: the input parameters of the deployment (map of strings)
- **Get deployment details**:
  - GET request to /deployments:
    - curl 'http://localhost:8080/deployments/<uuid>'
- **Delete deployment**:
  - DELETE request
    - curl 'http://localhost:8080/deployments/<uuid>'
- **Documentation**: http://indigo-dc.github.io/orchestrator/restdocs/#overview

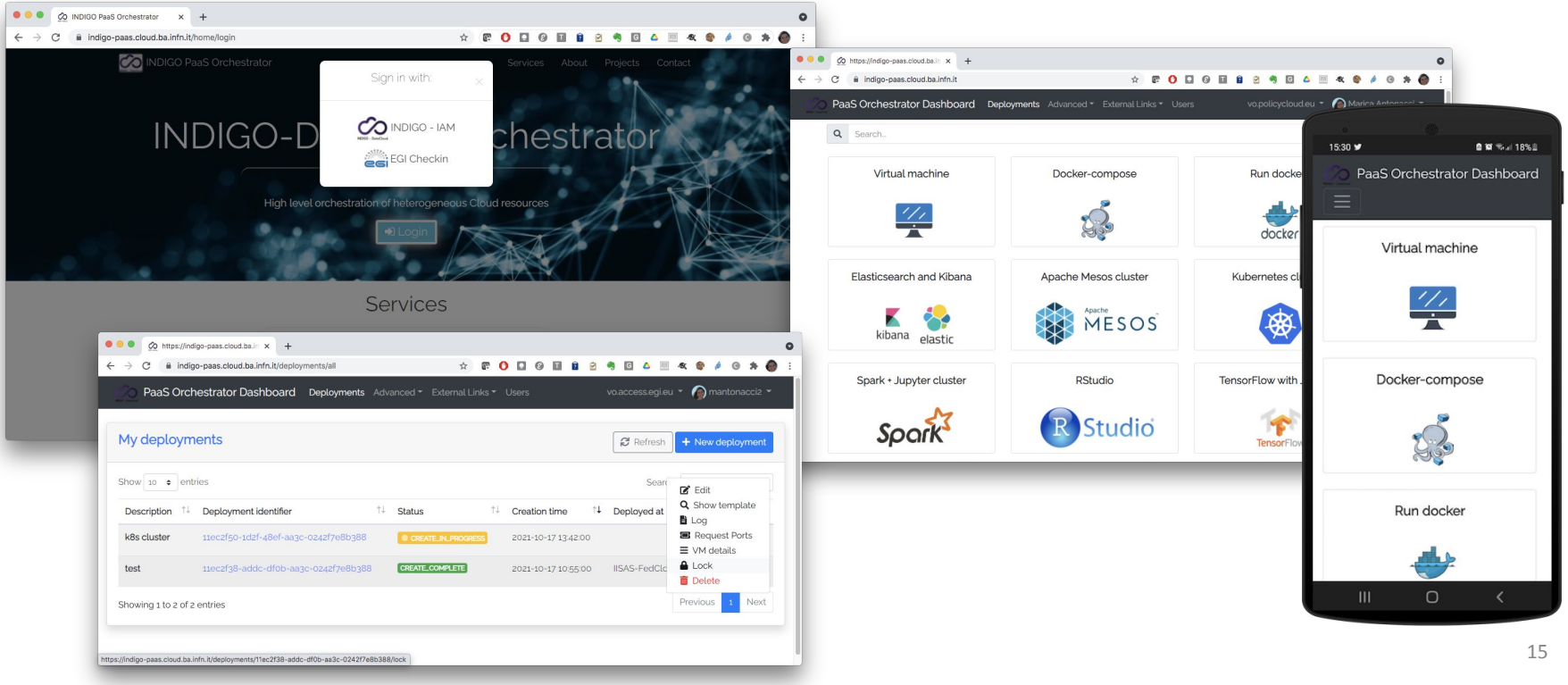
Orchent: The Orchestrator CLI

```
export ORCHENT_TOKEN=<your access token>
export ORCHENT_URL=<orchestrator_url>

usage: orchent <command> [<args> ...]

Commands:
  help [<command>...]
    Show help.

  depls
    list all deployments

  depshow <uuid>
    show a specific deployment

  depcreate [<flags>] <template> <parameter>
    create a new deployment

  depupdate [<flags>] <uuid> <template> <parameter>
    update the given deployment

  deptemplate <uuid>
    show the template of the given deployment

  depdel <uuid>
    delete a given deployment
```

Installation guide:
https://indigo-dc.gitbooks.io/orchent/content/admin.html
User guide:
https://indigo-dc.gitbooks.io/orchent/content/user.html

The PaaS Orchestrator dashboard

Empower users lowering the access barriers

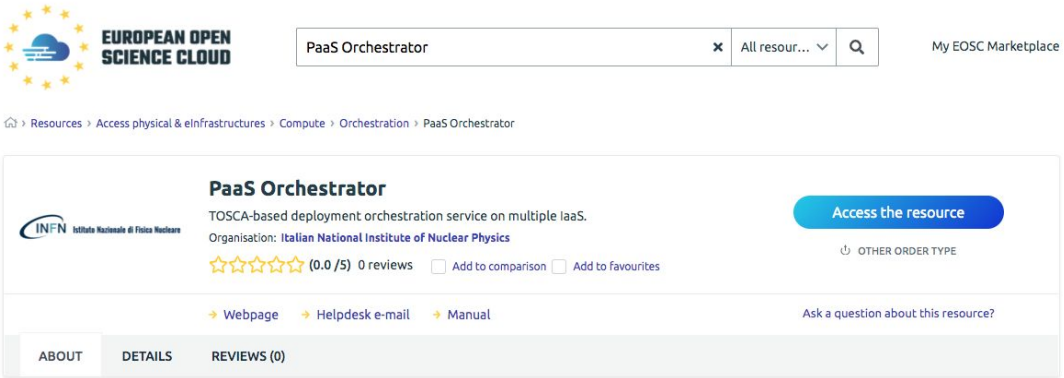


Live demonstration about how the INDIGO PaaS works:

- deploying a complete kubernetes cluster on a cloud provider (Openstack)
- deploying a Tensorflow docker container with GPU access

Thank you for your attention!

https://marketplace.eosc-portal.eu/services/paas-orchestrator



For more information and technical support mail to: indigo-paas-support@lists.infn.it

Backup slides

Deployment retry strategy

The Orchestrator implements a **trial-and-error** mechanism that allows to reschedule the deployment on the next available cloud provider from the list of candidate sites.

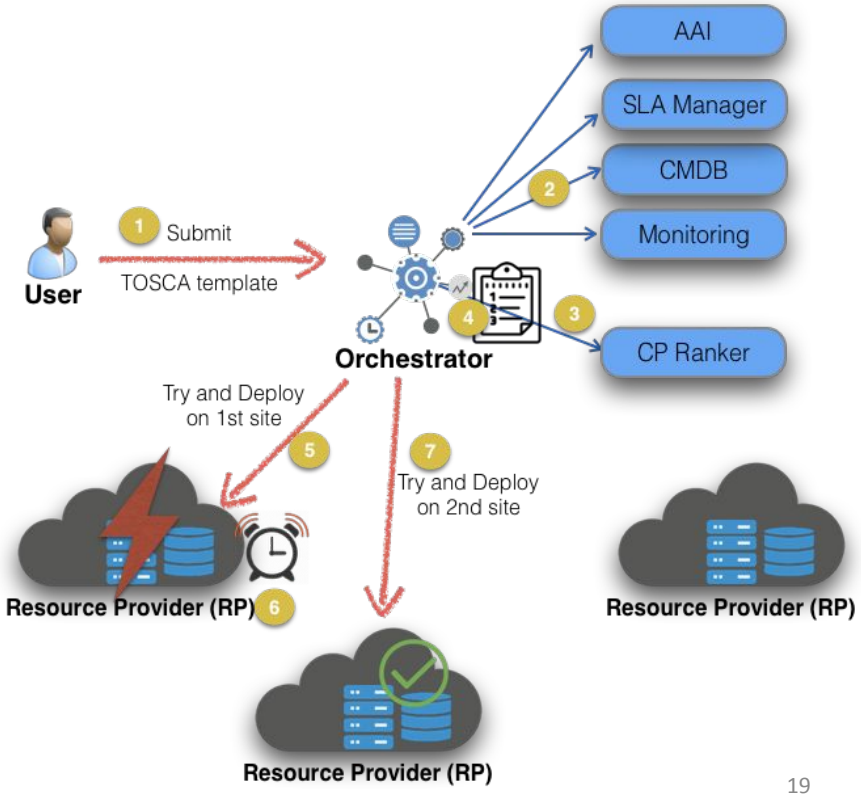
Example: the deployment fails due to a runtime error on the chosen site.

The implemented mechanism is able to address also the **timeout** in the deployment creation.

The user can specify

○ the maximum time for the single trial at each provider;

○ the overall maximum time for the deployment creation (including the possible retries).



Virtual Networking Orchestration

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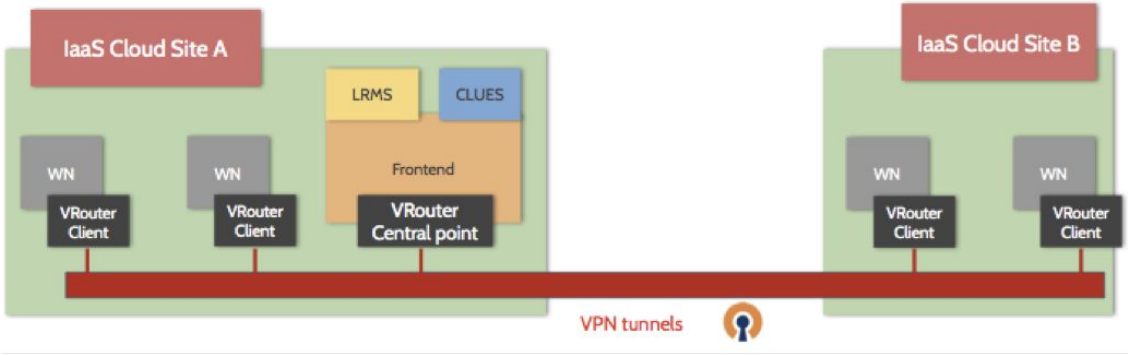
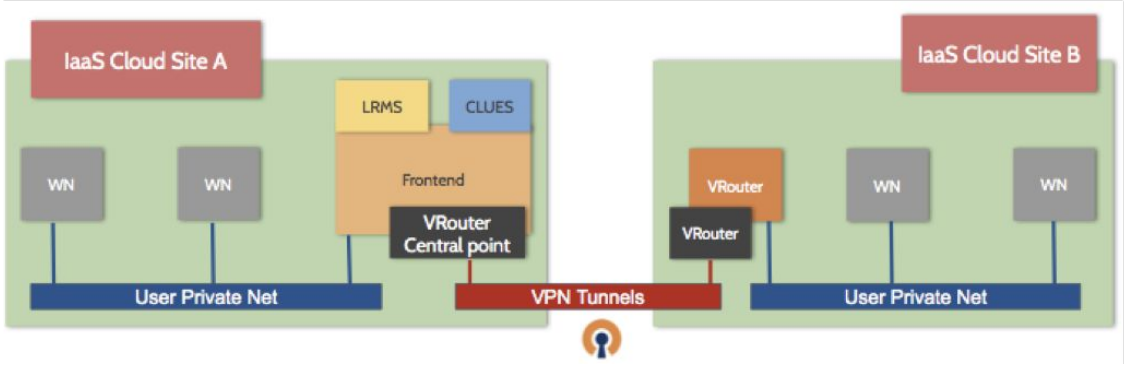
Scenario I:

exploits private networks already existing at the sites



Scenario II:

a dedicated private network is created for the deployment in both sites

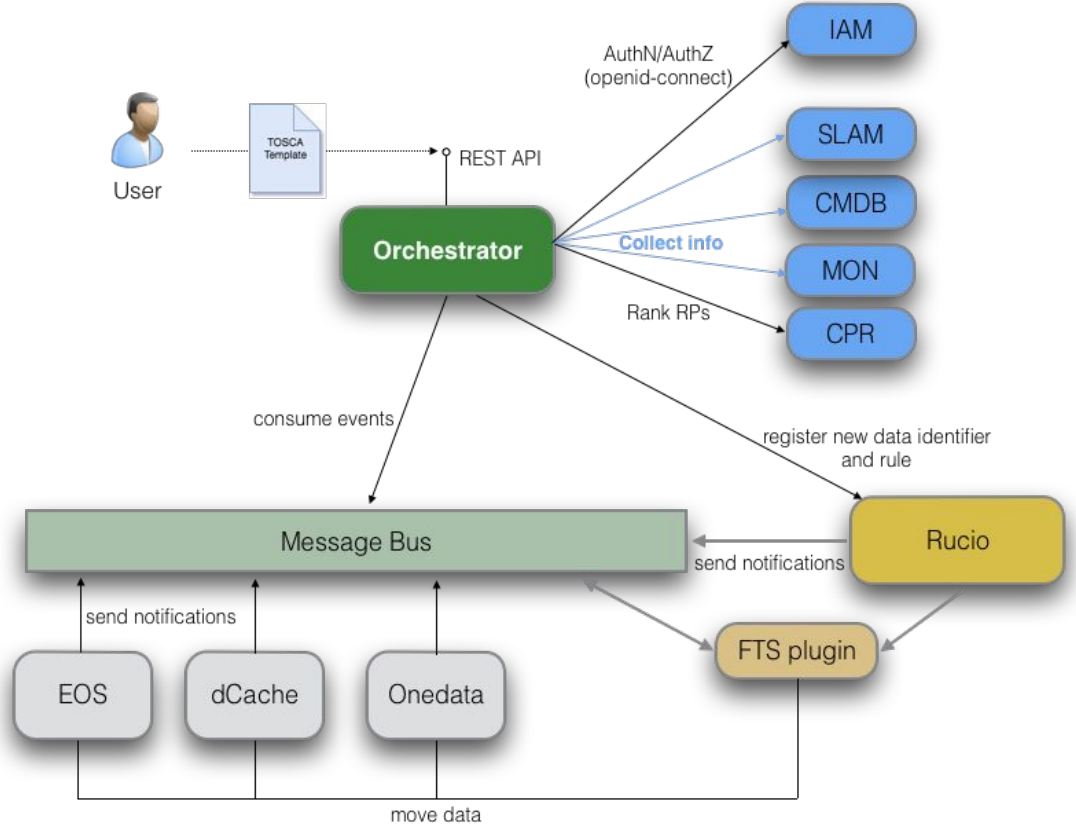


Data Placement and Orchestration

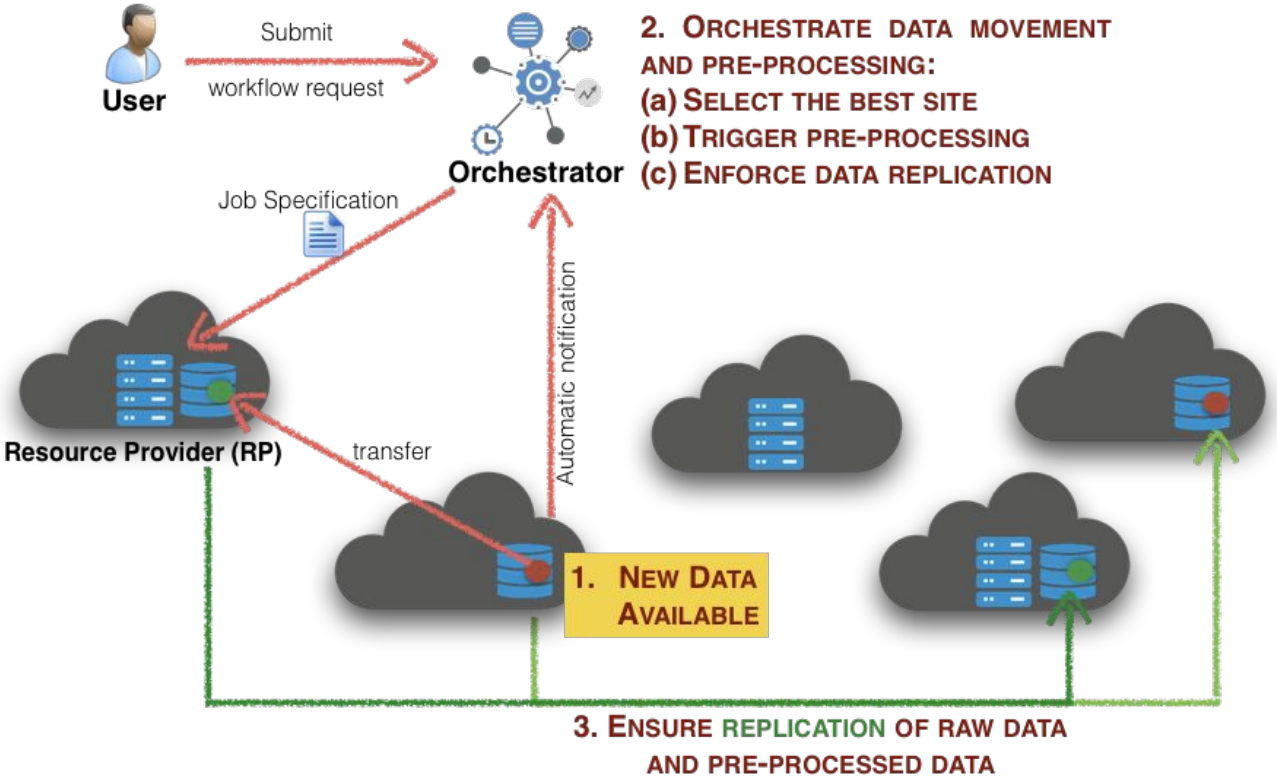
- **Data-aware scheduling**: the INDIGO Orchestrator is able to select automatically the best computing site based on the user data location
  - Data placement plugins available for Onedata and Dynafed

- **Data movement and orchestration**: Rucio, the data management system developed by Cern (initially for the ATLAS experiment), has been integrated in the INDIGO Orchestrator as a plugin to be used to steer the data movement
  - support workflows for data pre-processing at ingestion

Data Orchestration with Rucio



Use-case: Data Pre-processing at ingestion



Resources

- INDIGO-DataCloud: a Platform to Facilitate Seamless Access to E-Infrastructures: https://link.springer.com/content/pdf/10.1007/s10723-018-9453-3.pdf
- PaaS Orchestrator docs: https://indigo-dc.gitbook.io/indigo-paas-orchestrator/
- PaaS Orchestrator API docs: https://indigo-dc.github.io/orchestrator/
- PaaS Orchestrator code repo: https://github.com/indigo-dc/orchestrator
- INDIGO TOSCA types:
  - https://github.com/indigo-dc/tosca-types
  - Example templates: https://github.com/indigo-dc/tosca-types/tree/master/examples
- INDIGO Ansible Roles: https://galaxy.ansible.com/indigo-dc/
- Docker images: https://hub.docker.com/u/indigodatacloud/