Co-funded by the Horizon 2020
Framework Programme of the European Union
Grant Agreement Number 825532

Large-scale EXecution for Industry & Society

LEXIS

www.lexis-project.eu

HPC-CLOUD-BIG DATA CONVERGENT ARCHITECTURES +

RESEARCH DATA MANAGEMENT:

THE LEXIS APPROACH

ISGC 2021, TAIPEI, 2021-03-25

FOR THE LEXIS & LEXIS-WP3 TEAM:
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LEXIS WP3 (data) lead
LEIBNIZ SUPERCOMPUTING CENTRE (LRZ)

ABOUT LEXIS

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Large-scale EXecution for Industry & Society

LEXIS

www.lexis-project.eu

Topic:	HPC and Big Data enabled Large-scale Test-beds and Applications
Topic identifier:	ICT-11-2018-2019
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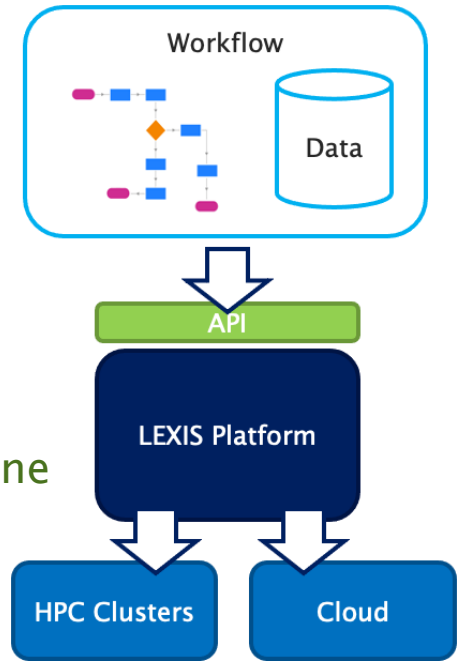
LEXIS project, led by Jan Martinovič, IT4I Supercomputing Center:

LEXIS project will build an advanced engineering **platform** at the confluence of **HPC, Cloud and Big Data** which will leverage large-scale **geographically-distributed resources** from existing HPC infrastructure, employ Big Data analytics solutions and augment them with Cloud services.

Driven by the requirements of the pilots, the LEXIS platform will build on best of breed **data management solutions** (EUDAT) and **advanced distributed orchestration solutions** (TOSCA), augmenting them with new efficient hardware capabilities in the form of Data Nodes and federation, usage monitoring and accounting/billing supports to realize an innovative solution.

KEY POINTS OF LEXIS PLATFORM

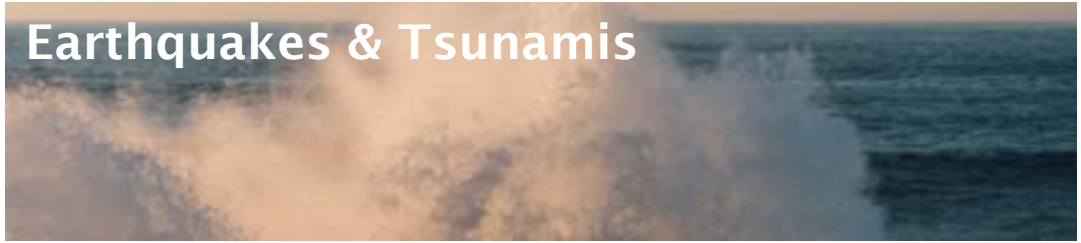
- Dynamic, complex Cloud- & High-Performance-Computing / Big Data workflows
  - orchestration in geographical federation with *YORC, HEAppE*
  - real-time deadline-aware workflows, etc.
- Cross-site (meta-)data federation
  - distributed data management and data discovery with *EUDAT/iRODS*
  - data transfers accelerated by Burst Buffer nodes; FPGAs/GPUs for on-line processing
- Web portal and interfaces for workflow set-up / execution
  - unified access to all services via *keycloak*-based LEXIS AAI
- Easy HPC/Cloud access for SMEs/Industry – Big Data for everyone
  - HPC-as-a-Service approach
  - control over resource usage
  - fine-grained accounting and billing for multiple HPC centres with *CYCLOPS*



LEXIS PILOT PROJECTS

General information - **https://lexis-project.eu**

Computation Fluid Dynamics (CFD), Rotating parts (gearboxes) – workflow automation with 3D Visualization: accelerated HW/SW coupling, live monitoring/post-processing



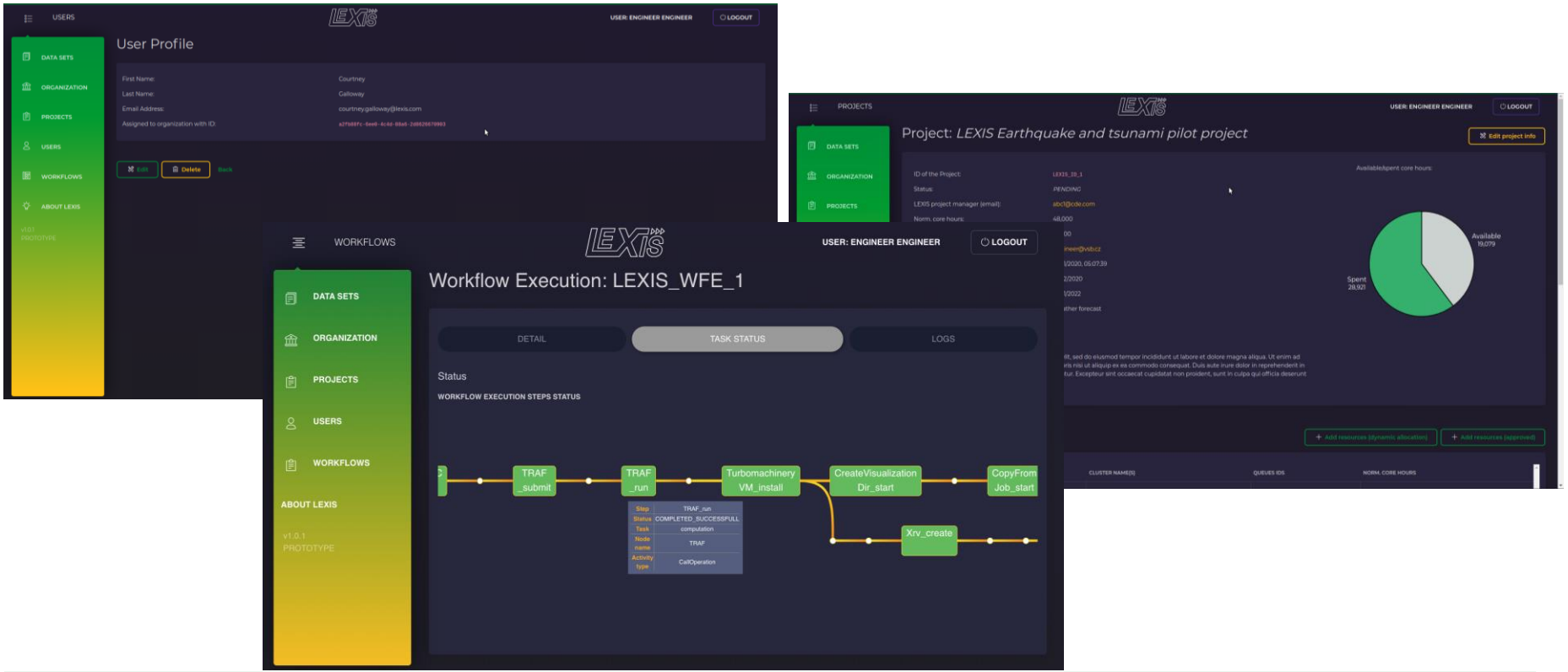
Earthquakes & Tsunami prediction models, geographic and urban databases, emergency organization, urgent computing

Weather & Climate models (WRF) and various post-processors for flood, wildfire & agriculture applications

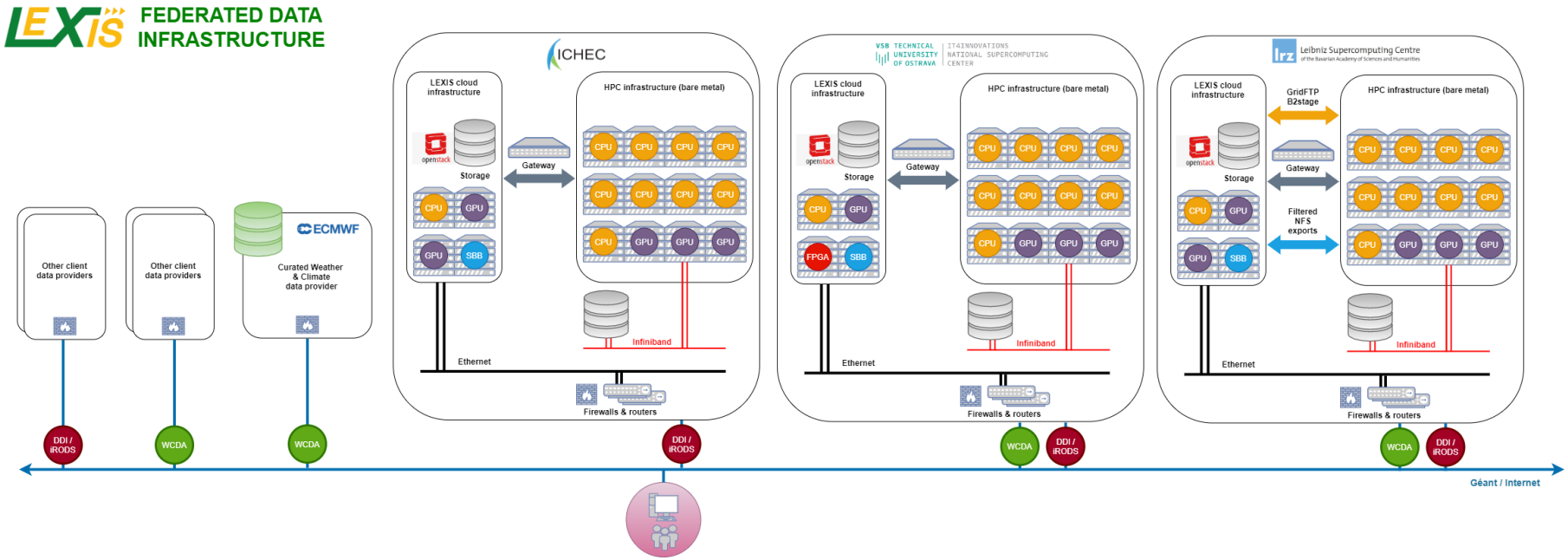
PLATFORM AND ORCHESTRATION

USER EXPERIENCE

LEXIS portal



LEXIS INFRASTRUCTURE OVERVIEW

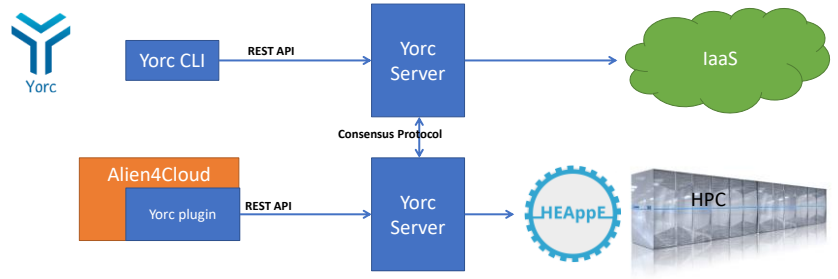


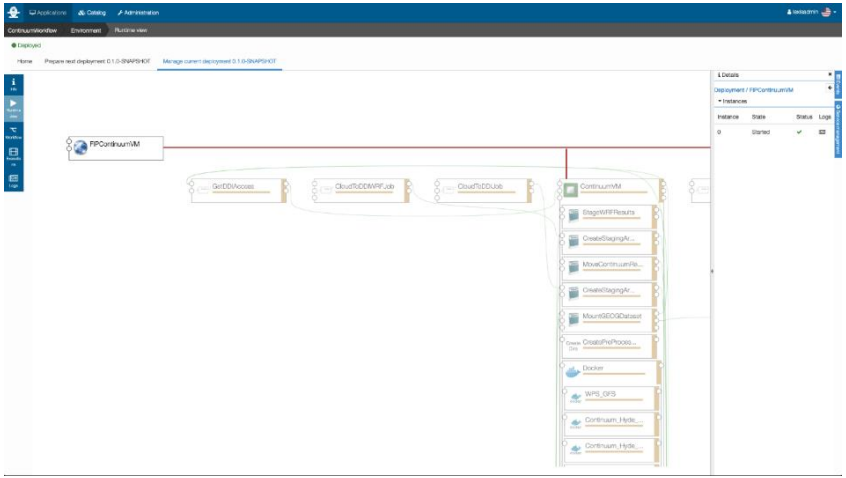
LEXIS ORCHESTRATION CONCEPT

HEAppE middleware + YORC (Ystia Orchestrator, based on TOSCA) + Alien4Cloud User Interface

From system to UI level:

- **HEAppE:** middleware for unified HPC and Cloud access
- **Yorc:** orchestration service backend, executes application workflows
- **Alien4Cloud:** orchestration service frontend:
  - Catalogue for storing workflow application templates and components
  - UI for defining new workflows
  - Client library + REST API

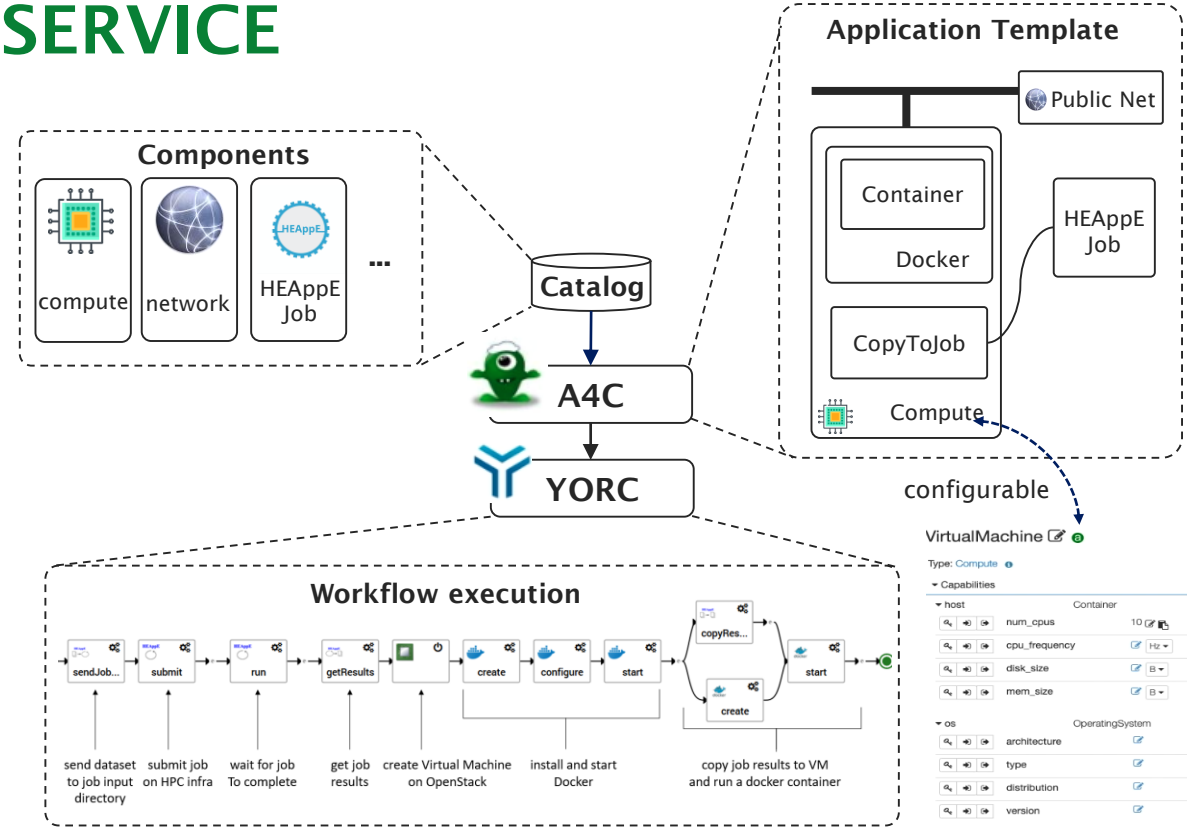




ORCHESTRATION SERVICE

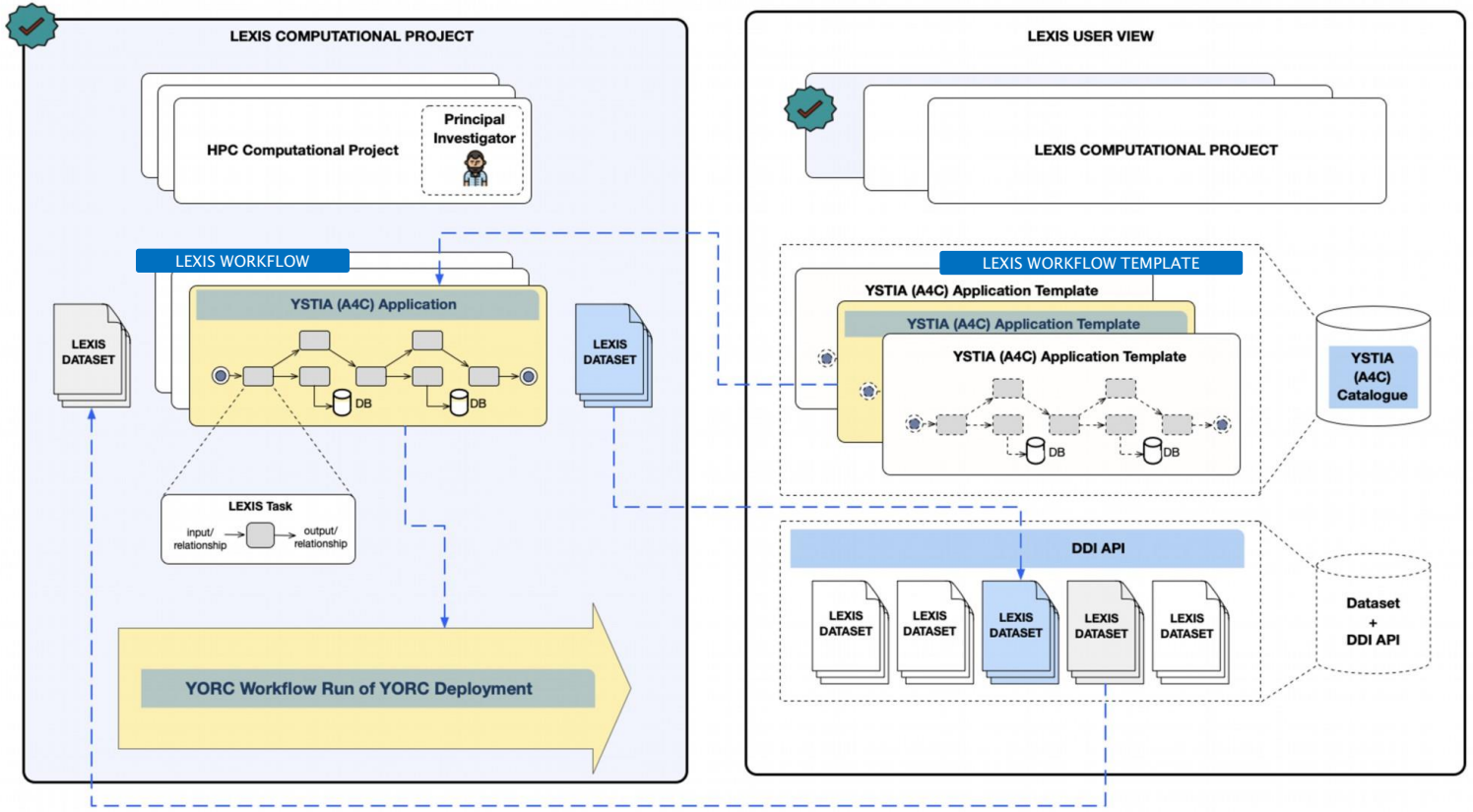
Workflow deployment

- Execution on (geographically distributed) HPC and Cloud resources
  - **Cloud:** via OpenStack built-in interface
  - **HPC:** job execution is mediated by HEAppE middleware
- Data management and orchestration policies
  - Leverage the **LEXIS DDI** service for an effective data transfer between systems
  - Placement of **workflow tasks** on the most suitable resource



https://github.com/alien4cloud/alien4cloud
https://github.com/ystia
http://heappe.eu

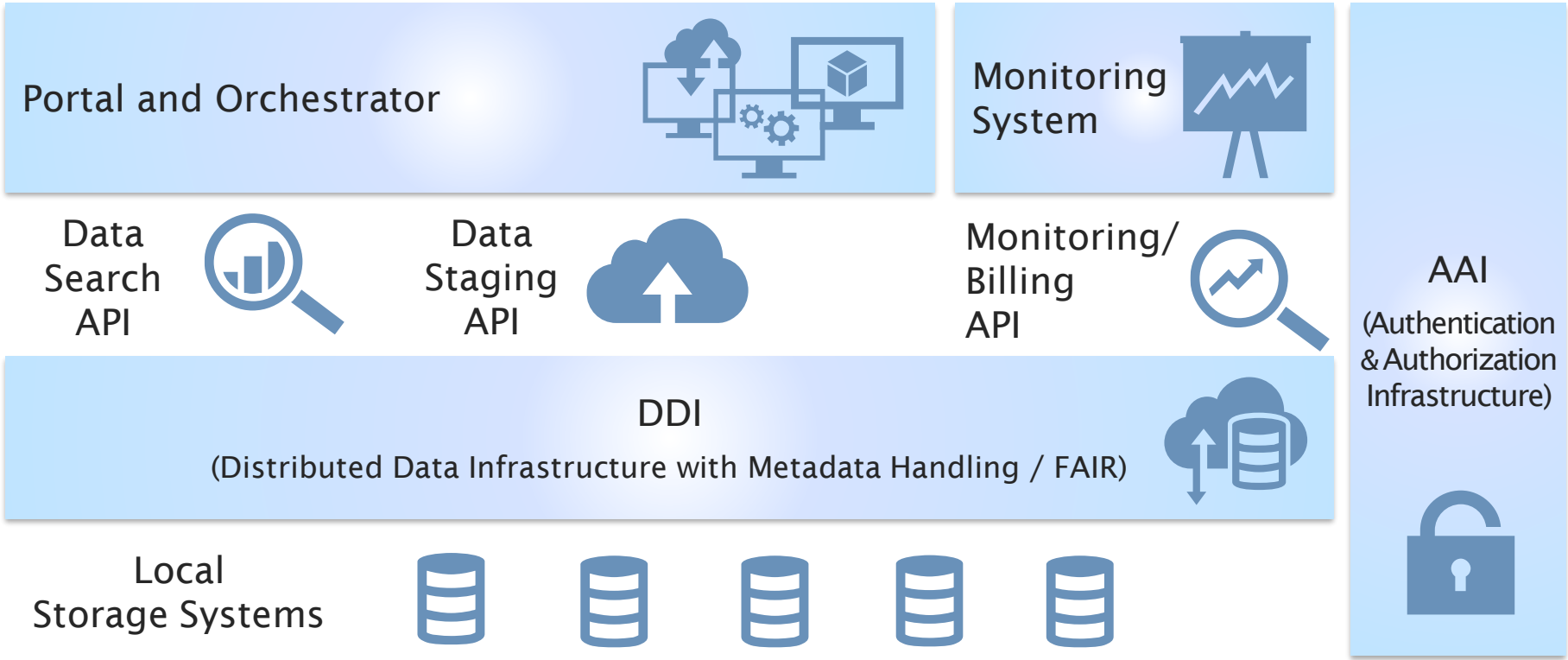
TERMINOLOGY – USER VIEW VS. TECHNOLOGY VIEW



LEXIS DATA SYSTEM
(DISTRIBUTED DATA INFRASTRUCTURE – DDI)

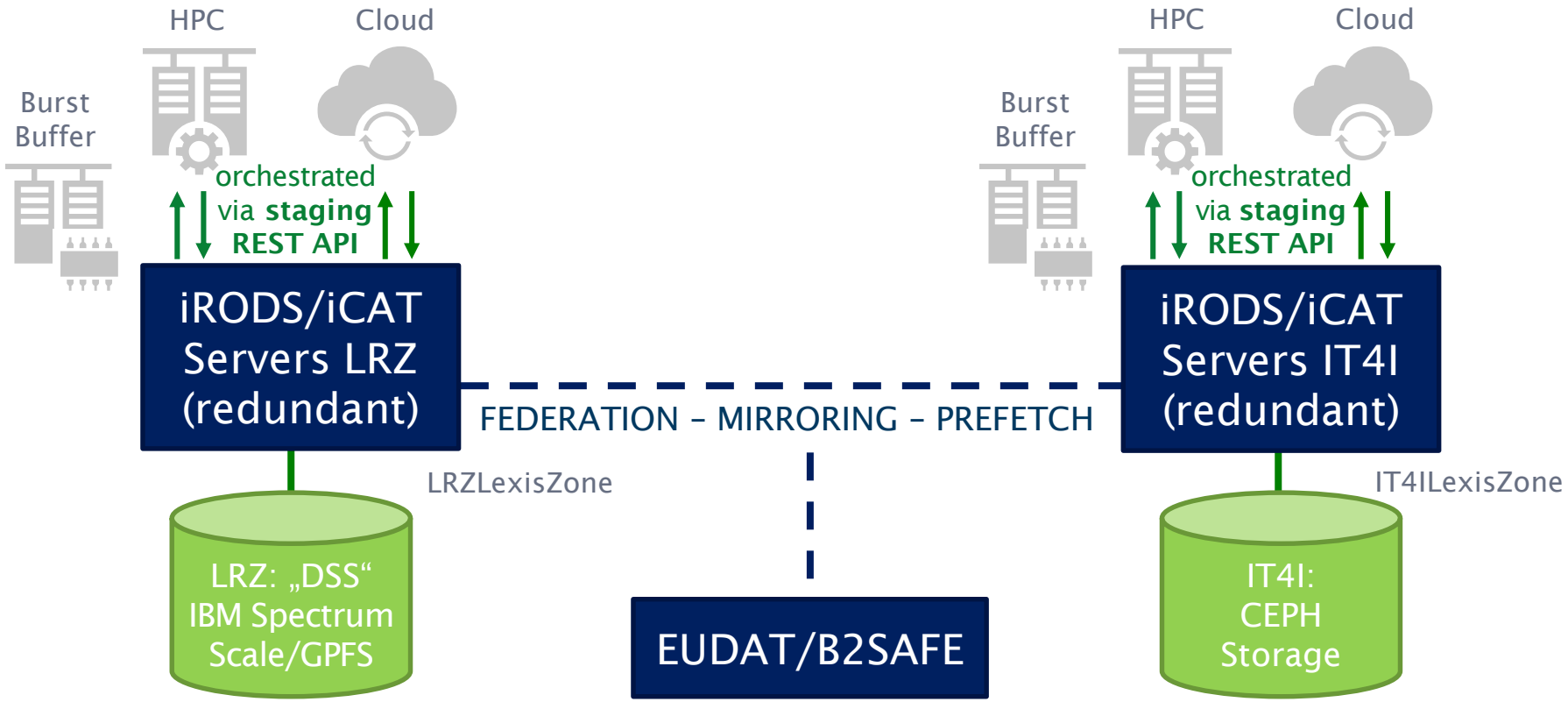
LEXIS DISTRIBUTED DATA INFRASTRUCTURE

Functionality in LEXIS ecosystem



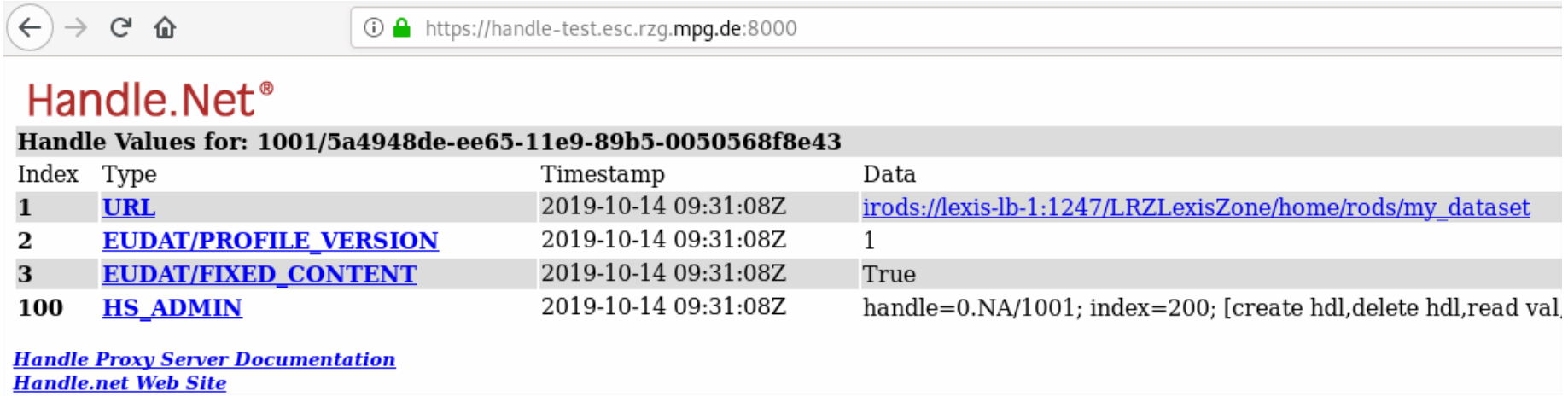
LEXIS DISTRIBUTED DATA INFRASTRUCTURE

Backend functionality in more detail



INTEGRATION WITH EUDAT: B2HANDLE

- We equip data with EUDAT-B2HANDLE PIDs, based (as DOIs) on the Handle System (IETF RFCs 3650/51/52)
- Aim: long lasting references in
  - data management (B2SAFE)
  - search (B2FIND…), and
  - publication



LEXIS INTEGRATION WITH REST APIS: STAGING API

Overview of the Staging API

Endpoint	Method	Request body	Response body

/stage	POST	{
		"source_system" : "lrz_iRODS",
		"source_path":
		"public/testruben/dataset-16168",
		"target_system": "lrz_staging_area" ,
		"target_path": "DDIStaging/dataset-161684"
		}
			{
			"request_id":
			"cc19e4a8-e4cf-4bca-bf7a-2bc9a27c44d6"
			}

/stage/<request_id>	GET	-	{
			"status": "Transfer completed"
			}or
			{
			"status": "In progress"
			}

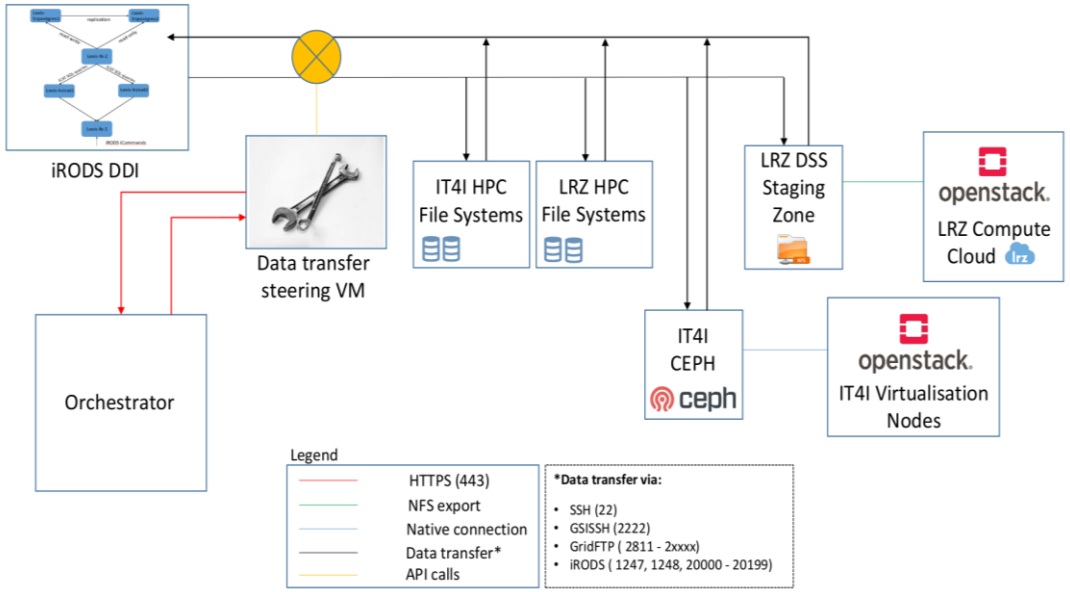
/delete	DELETE	{
		"target_system": "lrz_staging_area" ,
		"target_path":"DDIStaging/dataset-161683"
		}
			{
			"request_id": "cc19e4a8-e4cf-4bca-bf7a-2bc9a27c44d6"
			}

/delete/<request_id>	GET	-	{
			"status": "Data deleted"
			}or
			{
			"status": "In progress"
			}

BEHIND THE SCENES: LEXIS STAGING API

System View

- LEXIS orchestrator can move data by simple HTTP request
  - between iRODS,
  - Cloud, and
  - HPC resources at all LEXIS centers.
- Uses LEXIS AAI and the HEAppE middleware
- Queuing system using Celery and RabbitMQ handles requests asynchronously.



THE FAIR SIDE OF LEXIS: METADATA, PIDS

Findable, Accessible, Interoperable, Reuseable Research Data

- Most basic FAIR data requirements:
  - metadata
  - (world-)unique dataset identifier
- Metadata in LEXIS:
  - stored in iRODS Attribute-Value(-Unit) store for each data set
  - schema oriented at the basics from DataCite (schema.datacite.org)
- PIDs in LEXIS: B2HANDLE
- Aiming for findability of LEXIS public data sets via EUDAT-B2FIND

```
      @lexis-lb-1:~$ ils
/LRZLexisZone/home/rods/my_dataset:
      @lexis-lb-1:~$ iput opensearch.txt
      @lexis-lb-1:~$ ils
/LRZLexisZone/home/rods/my_dataset:
  opensearch.txt
      @lexis-lb-1:~$ irule -F eudatPidsColl.r
*newPID = 1001/5a4948de-ee65-11e9-89b5-0050568f8e43
      @lexis-lb-1:~$ imeta ls -C /LRZLexisZone/home/rods/my_dataset
AVUs defined for collection /LRZLexisZone/home/rods/my_dataset:
attribute: EUDAT/FIXED_CONTENT
value: True
units:
----
attribute: PID
value: 1001/5a4948de-ee65-11e9-89b5-0050568f8e43
units:
```

LEXIS OPEN CALL

LEXIS – OPEN CALL – OBJECTIVES

Objective: work with test users (including SMEs/industry) and various projects to

- validate platform w/r/t
  - technologies developed/deployed,
  - orchestration paradigm,
  - usability of data sets and DDI, and
- refine platform to warrant
  - optimum performance at end of the project, and
  - exploitation post-end-of-project.

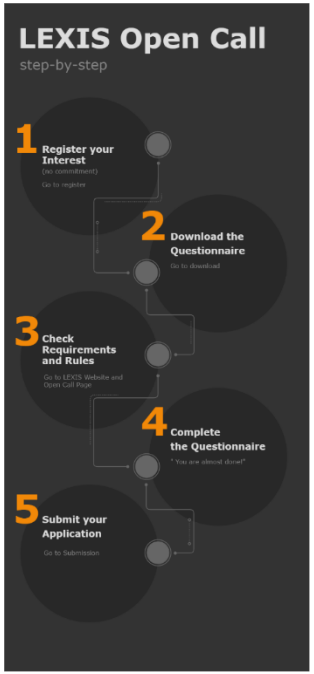
Benefit for applicants:

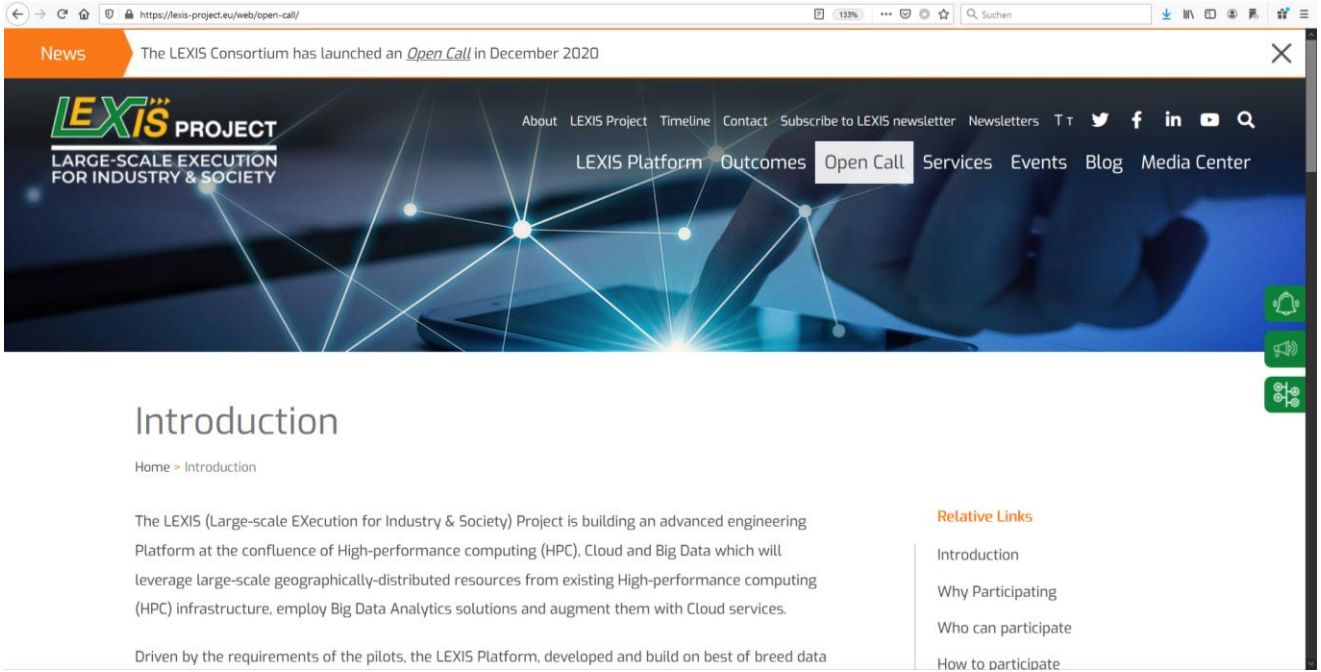
- test HPC/Cloud/Big Data platform with large resources “for free”
- get individual project & tech support + training from LEXIS team

LEXIS & OPEN CALL WEBSITE

Have a look on: https://lexis-project.eu/web/open-call !

- 2nd stage running: Free application – reviewed by LEXIS Open Call Board
- Platform testing up to Q4/2021





THANKS!

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Large-scale EXecution for Industry & Society

LEXIS

CONSORTIUM

VSB TECHNICAL UNIVERSITY OF OSTRAVA | IT4INNOVATIONS NATIONAL SUPERCOMPUTING CENTER

Avio Aero — A GE Aviation Business

Outpost24

EURAXENT

lrz Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities

ICHEC Irish Centre for High-end Computing

cima RESEARCH FOUNDATION

ITHACA Information Technology for Humanitarian Assistance, Cooperation and Action

cea From research to industry

EIFFAGE TESEO

GFZ Helmholtz Centre Potsdam

NUMTECH L'atmodélisation

ECMWF

FONDAZIONE links PASSION FOR INNOVATION

AWI

CYCLOPS

BAYNCORE LABS