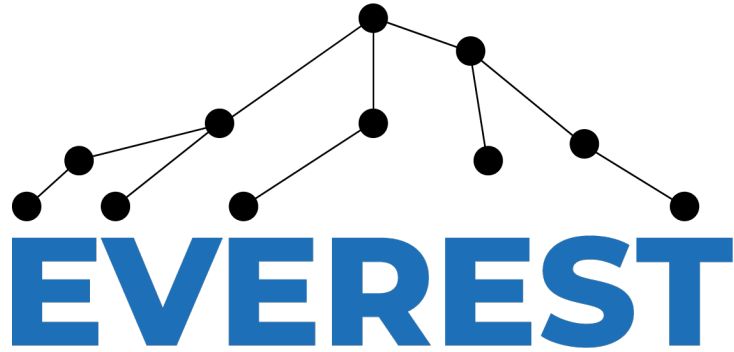
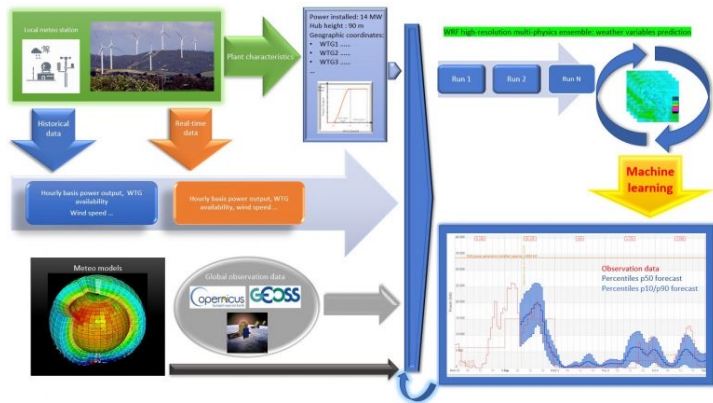


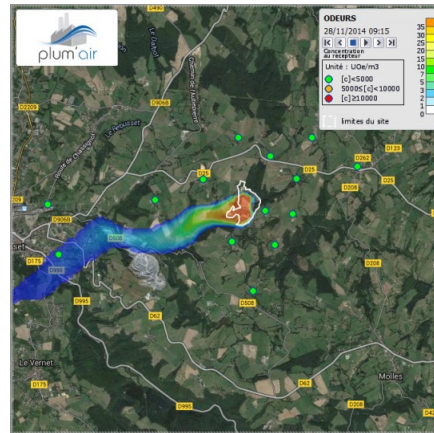
The LEXIS Platform

Easy access to heterogenous computational workflows execution

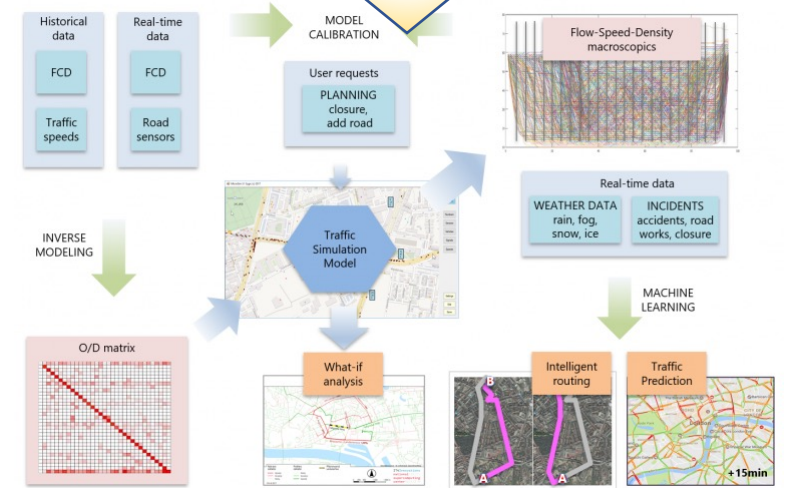
HiPEAC 2022 Everest workshop | 22/06/2022

Renewable-energy prediction



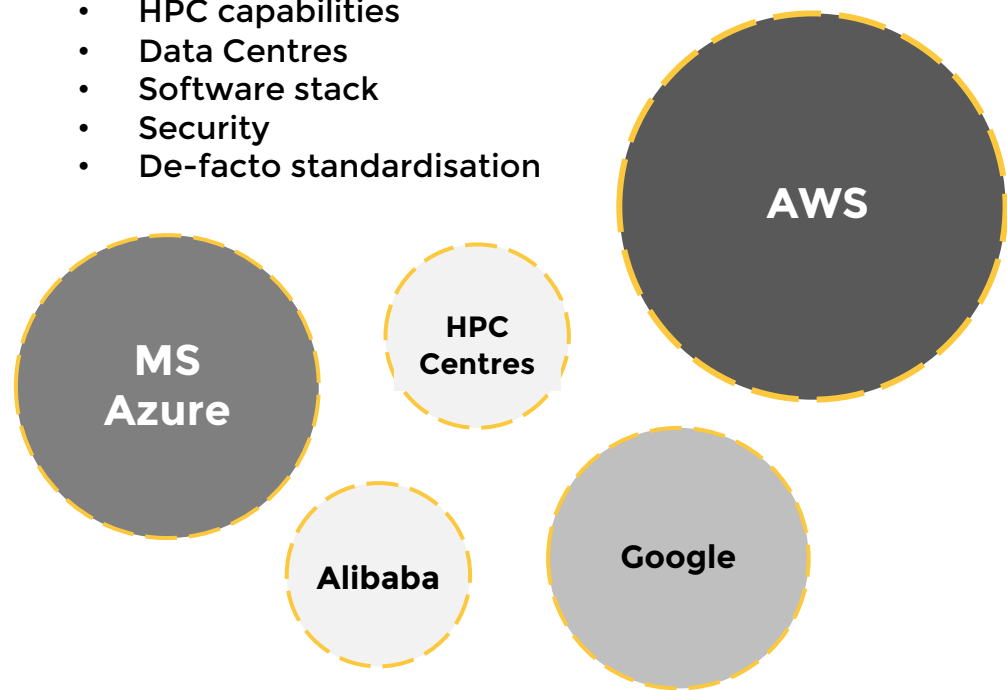
Air-quality monitoring



Traffic modeling

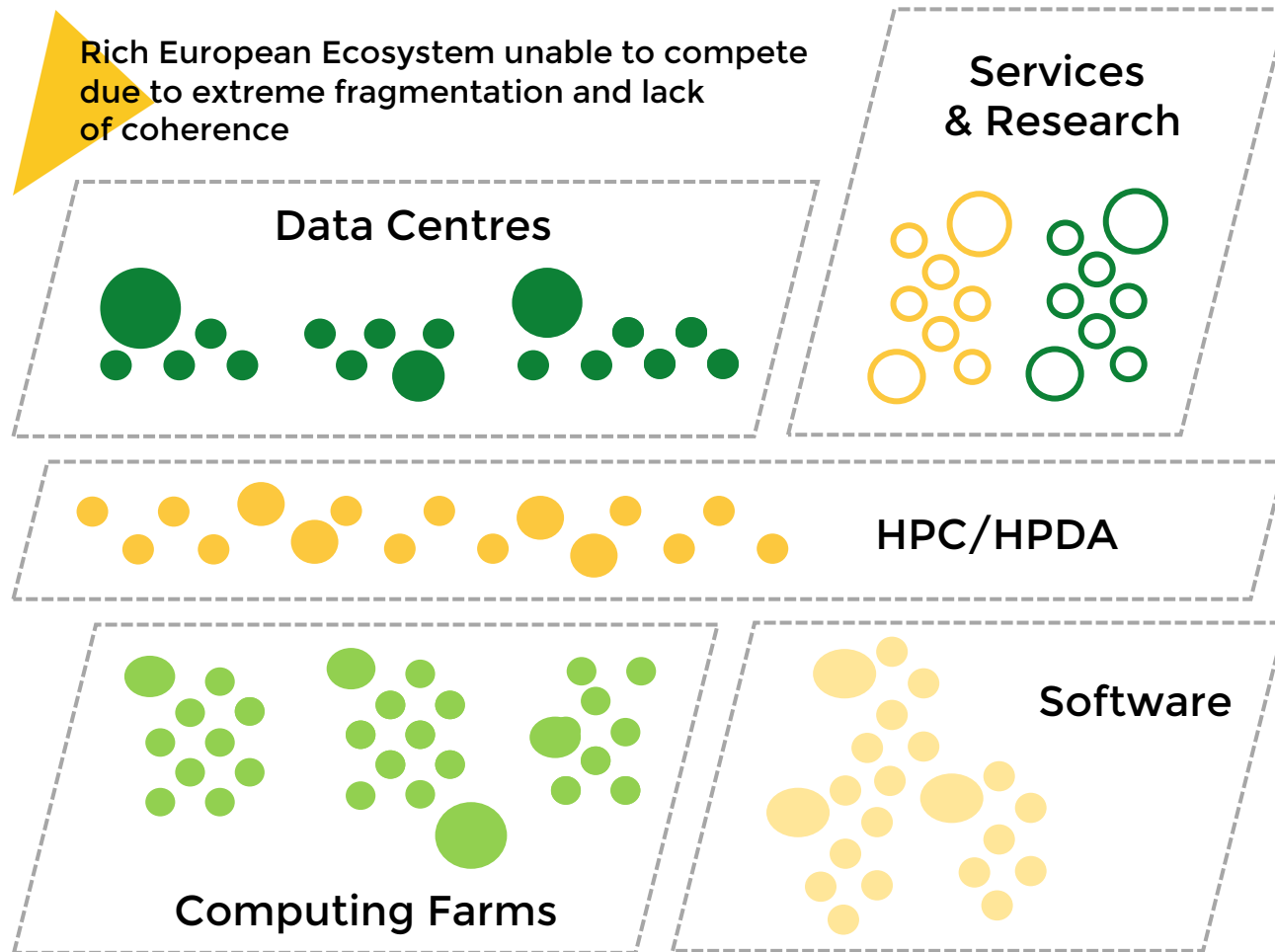
Private Operators integrating with high level of coherence:

- Computing Infrastructures
- HPC capabilities
- Data Centres
- Software stack
- Security
- De-facto standardisation

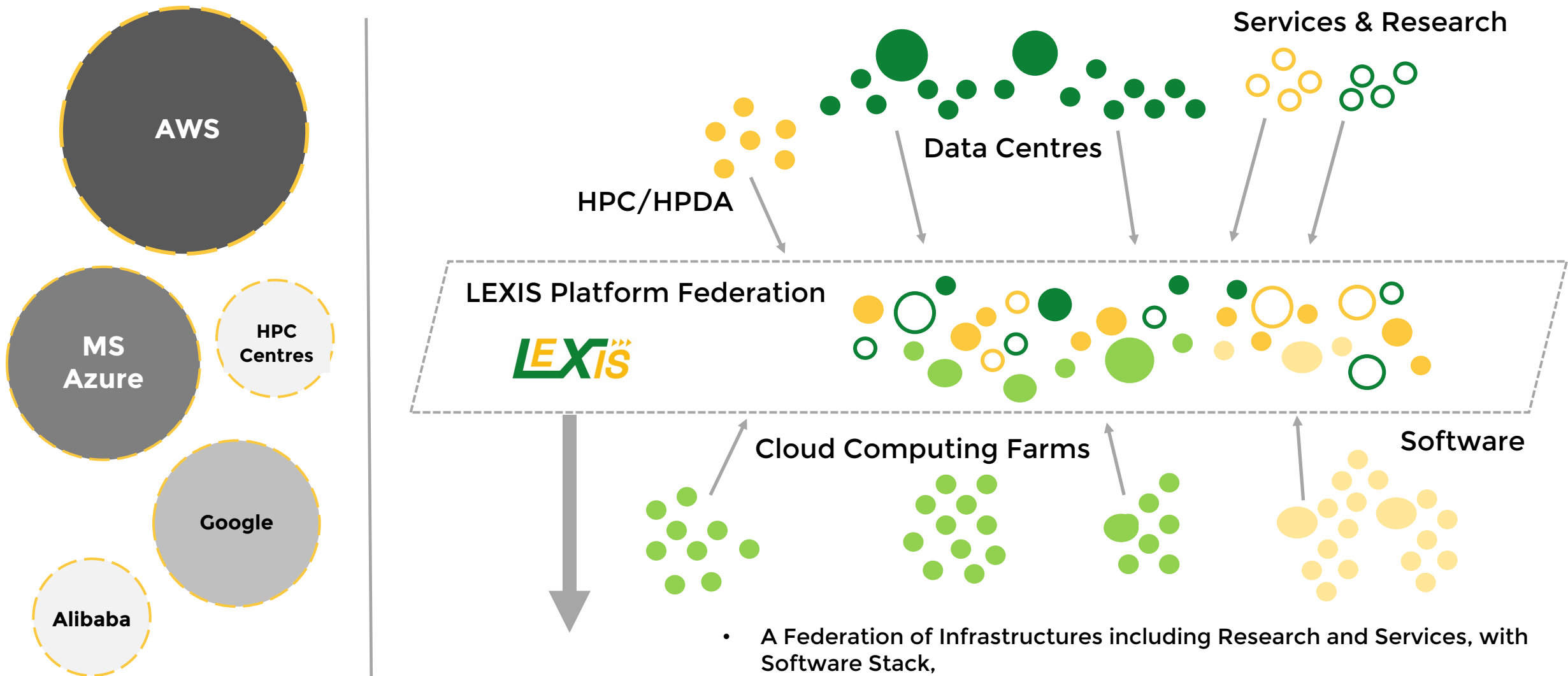


>80% of European Market in US and Chinese hands

Rich European Ecosystem unable to compete due to extreme fragmentation and lack of coherence



- No operator has a critical size / Silo culture
- Mix of private and publicly funded operators
- Very difficult to address the Digital Continuum
- No Sovereignty possible for Europe



- A Federation of Infrastructures including Research and Services, with Software Stack,
- Building Coherence, Solving the Private/Public difficulties,
- Performance, Openness, Orchestration, Coherence, Security for the full Digital Continuum
- Ready for compliance with EU Digital Sovereignty policies (GAIA-X or ...)

2018 – LEXIS Platform concept

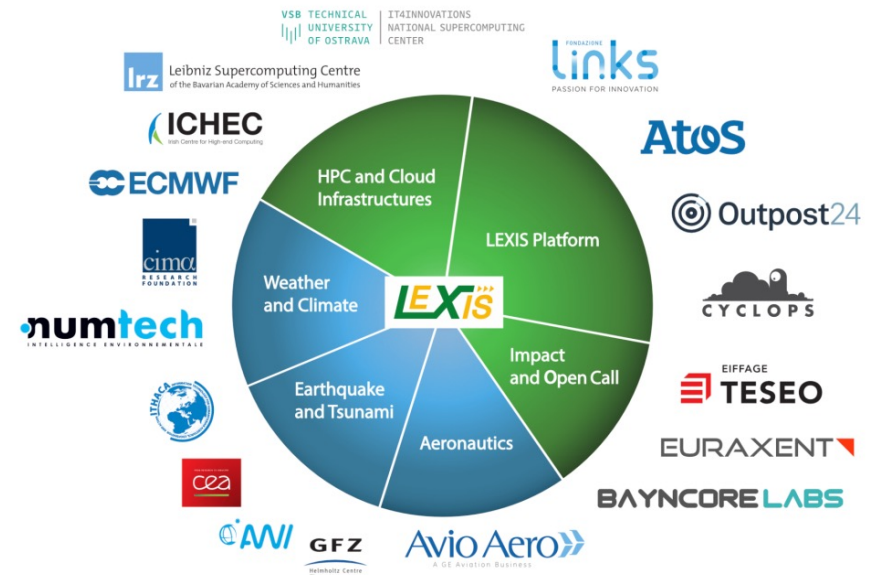
- Technical Concept
- Creation of a Consortium – 17 members, from Germany, Czech Republic, France, Ireland, UK, Italy, Switzerland
- Submission of the LEXIS Project to the EU Commission – Programme H2020
- Approval by the EU Commission - total budget circa 14 millions € - Grant agreement 825532
- Coordinator: IT4Innovations – National Supercomputing Centre of Czech Republic (Dr. Jan Martinovic)

2019 – Start of the project – 3 years timeline

- Project ending December 2021
- Completion validated by the EU Commission June 2022
- Exploitation post-end of project: starting now

2022 – Onward

- Technical tuning & development
- Enrolling new partners (Infrastructures, Data, Services)
- Structuration of legal entity
- Funding



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 825532.

From inception LEXIS has been built by an ecosystem made of representants of:

- Industries, (4)
- Research Organisations (6)
- Super computing centres (4)
- Service companies (4)
- SMEs and Start-ups (5)

The LEXIS Platform will further develop by capitalising on:

- Existing partners,
- Developing the number of infrastructures as members of the federation,
- Strongly reinforcing services by welcoming new Service partners,
- Increase technical ways for integration, interconnections and cooperation with the addition of new components to the federation via development of APIs,
- Digital Sovereignty European framework (GAIA-X or else).



IT4I
Supercomputing Centre



Atos
Industry



LINKS
Research Organisation



TESEO
Industry



CEA
Research Organisation



LRZ
Supercomputing Centre



ECMWF
Supercomputing Centre



ITHACA
Research Organisation



CIMA
Research Organisation



AVIO Aero
Industry



GFZ
Research Organisation



AWI
Research Organisation



Outpost24
SME



Cyclops Labs
SME



BAYNCORE
SME



NUMTECH
SME

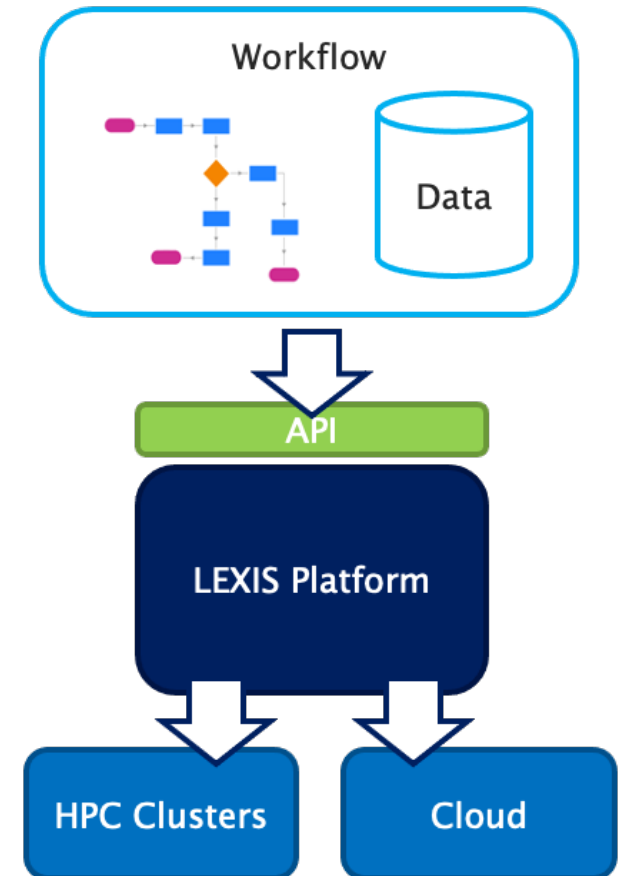


ICHEC
Supercomputing Centre

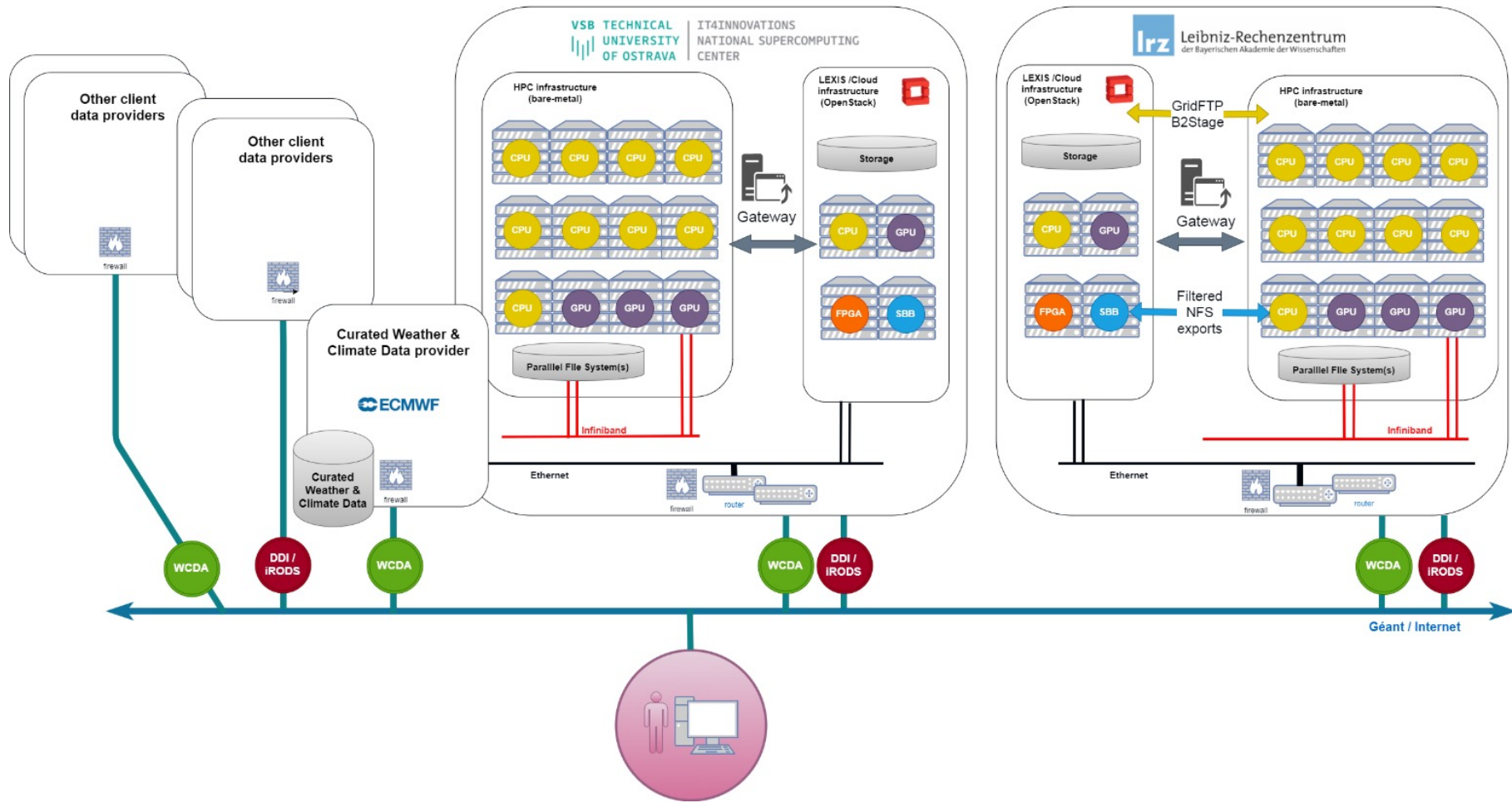


EURAXENT
SME

- **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*



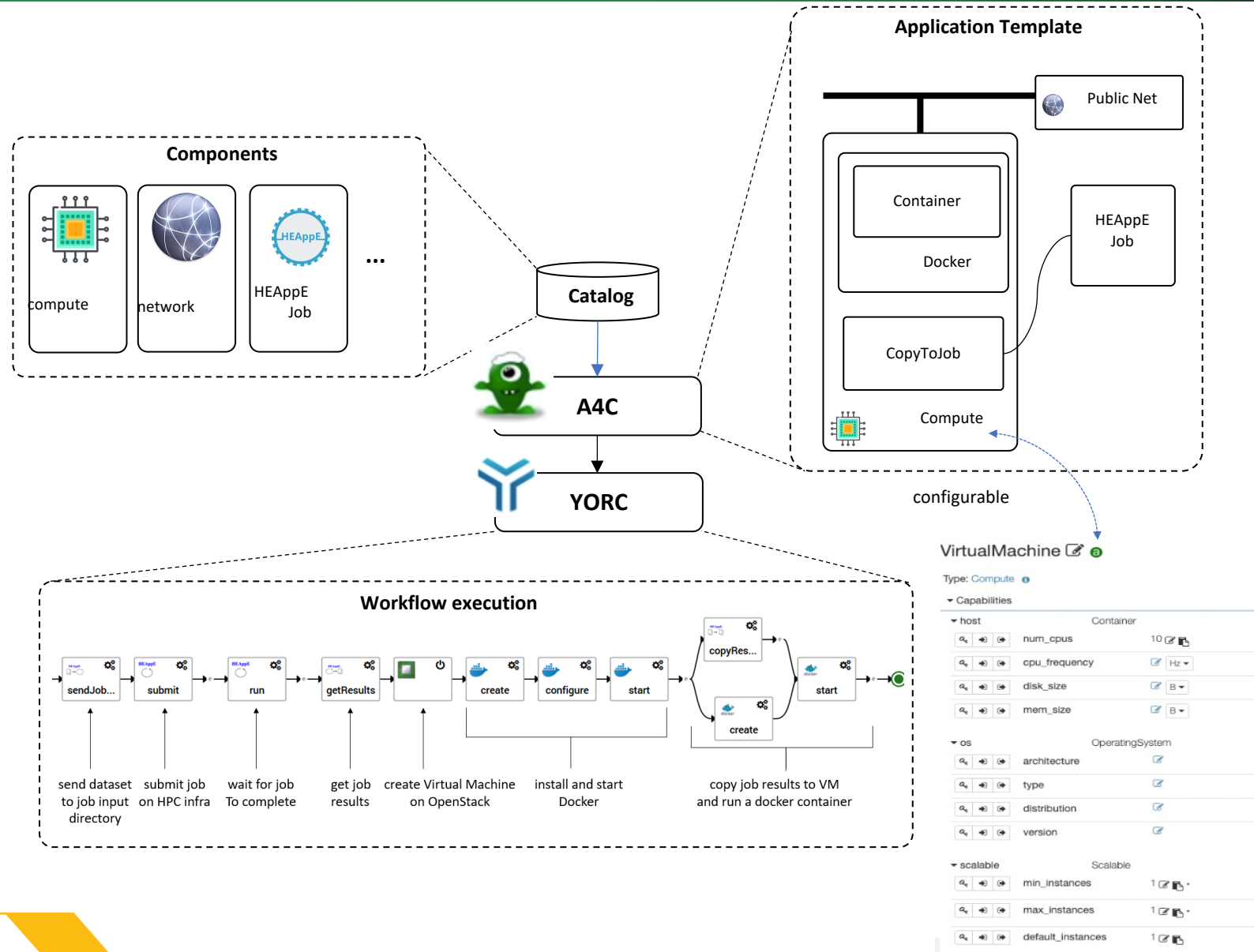
LEXIS Federated data infrastructure



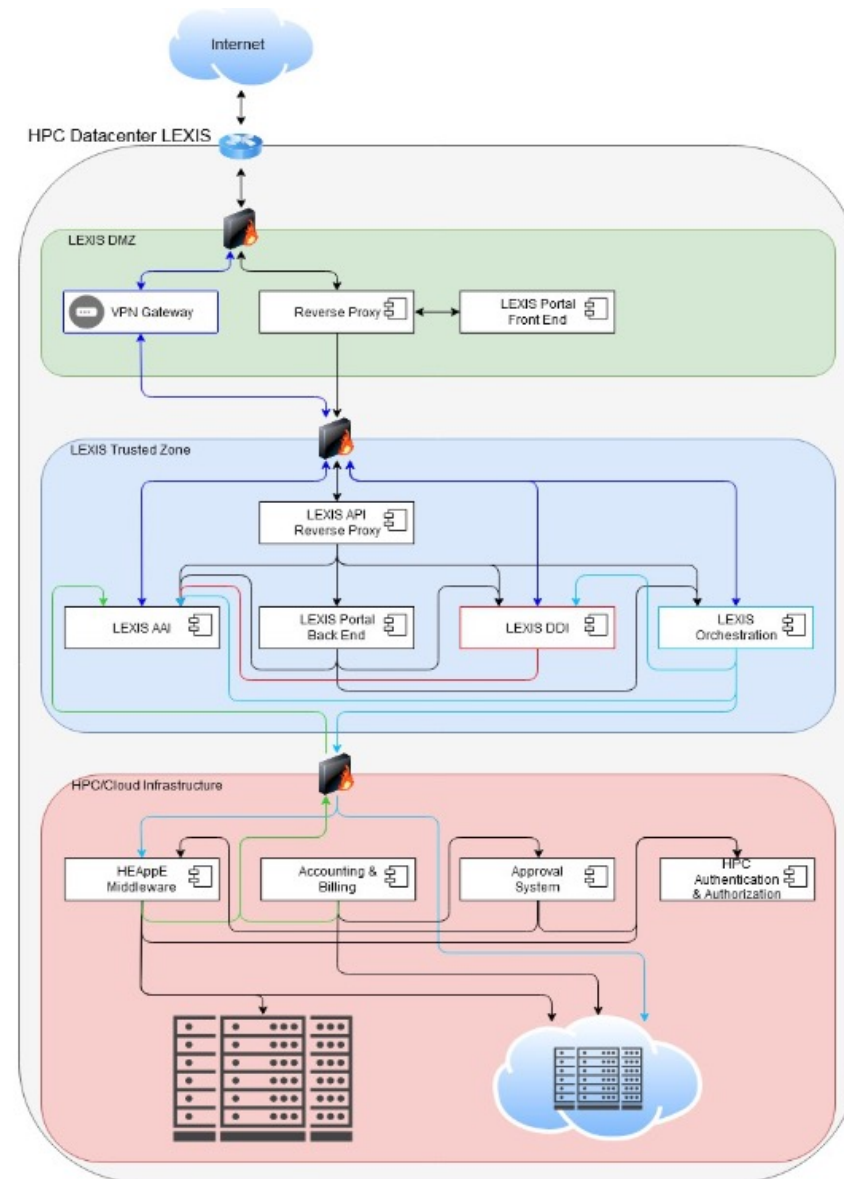
- Federation of European computing centres
- HPC & Cloud service providers, Data providers
- Unified & distributed data management
- Orchestration
- Federated Authentication & Authorization Infrastructure (AAI)
- Masking of technical and operational differences across organizations

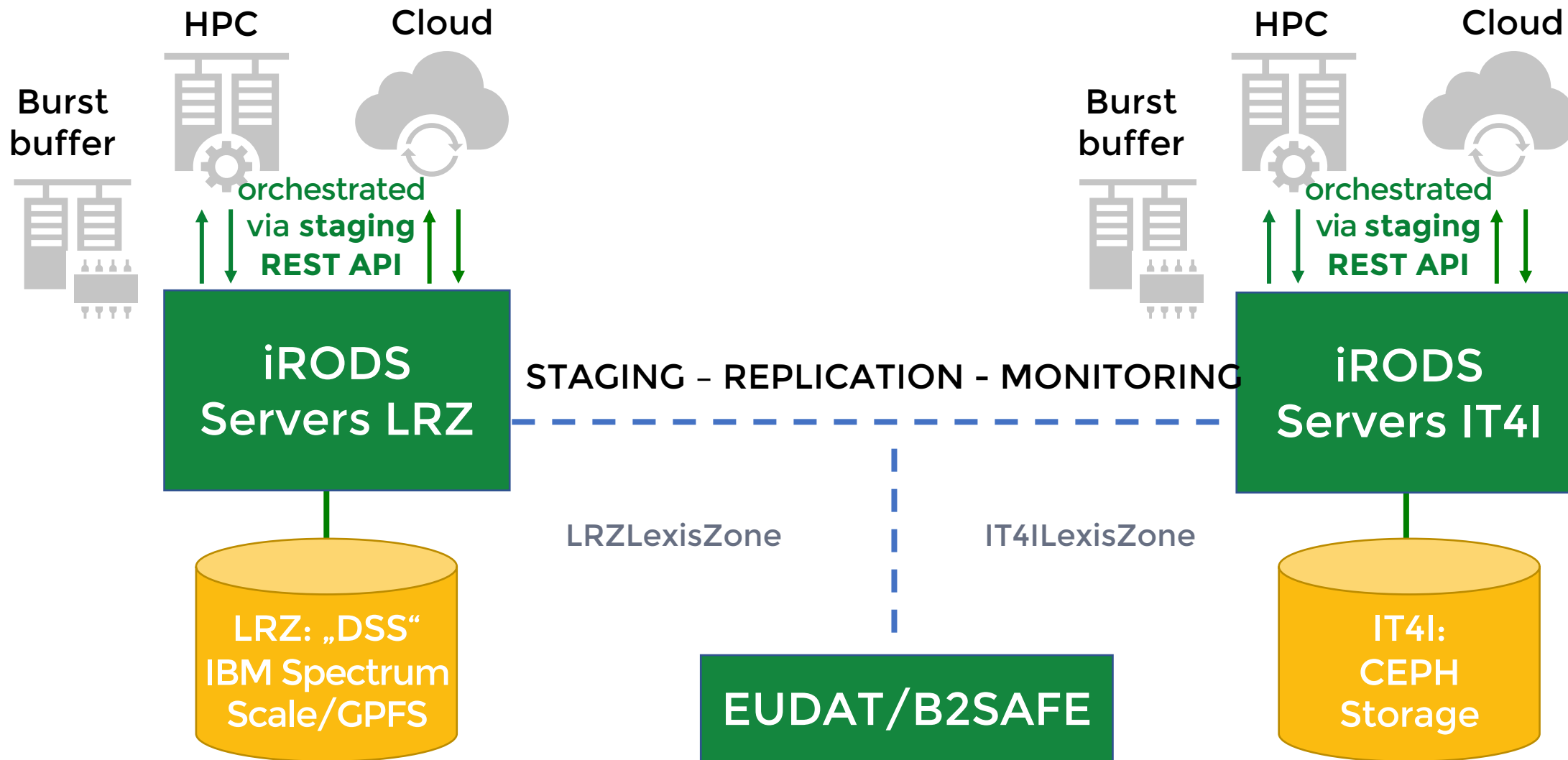
- Execution on geographically distributed HPC and Cloud resources
 - **Cloud:** via OpenStack built-in interface
 - **HPC:** job execution is mediated by HEAppE middleware
- Data management and orchestration policies
 - Leverage the LEXIS DDI service for an effective **data transfer** between systems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

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



- Custom AAI solution with trusted access to HPC with PI approval
- Security-by-design
 - Zero trust, minimal attack surface, separation of concerns
- Modern frameworks
- HPC infrastructures are protected
 - Isolated by the HEAppE middleware (developed in IT4I)
 - Deployed in both IT4I and LRZ
- Flexible
 - Blurs differences between HPC centres
 - Provides SSO across the LEXIS federation





Aeronautics



Computation Fluid Dynamics (CFD),
Rotating parts (gearboxes),
3D Visualization

Earthquakes & Tsunamis



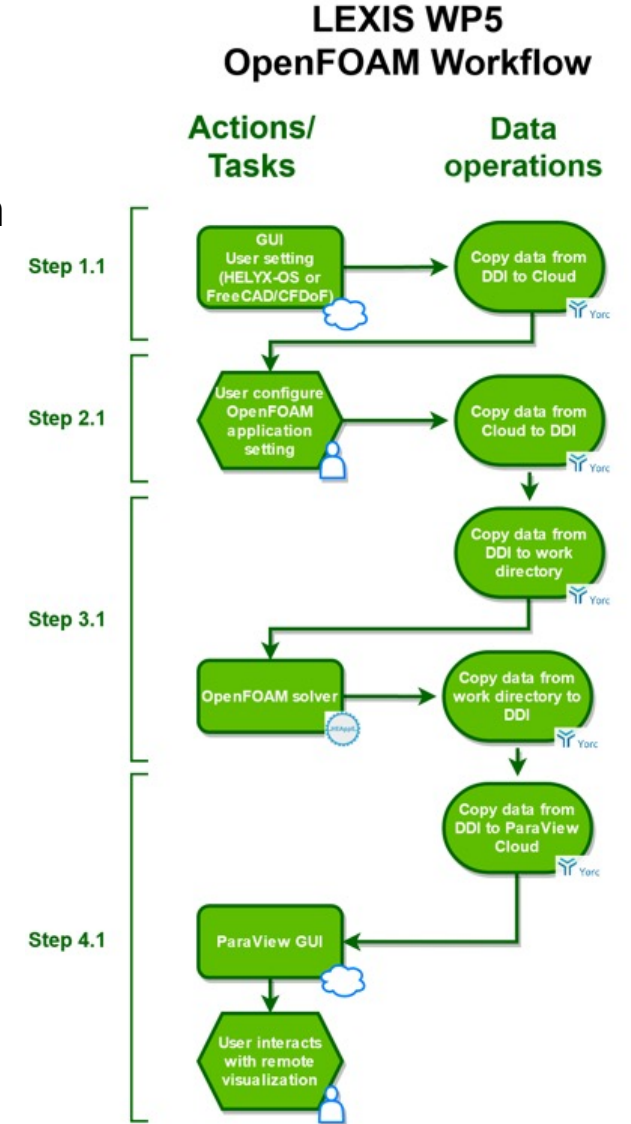
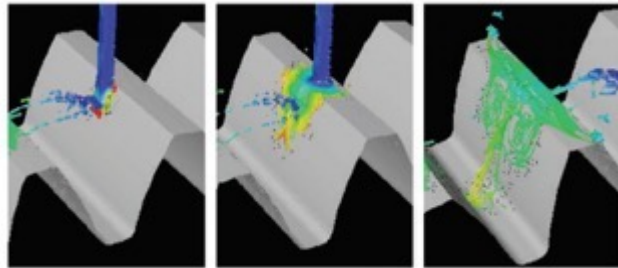
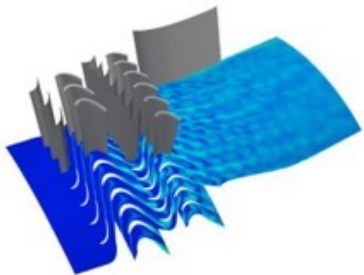
Earthquakes & Tsunami prediction models,
geographic and urban databases, emergency
organization, urgent computing

Weather & Climate



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

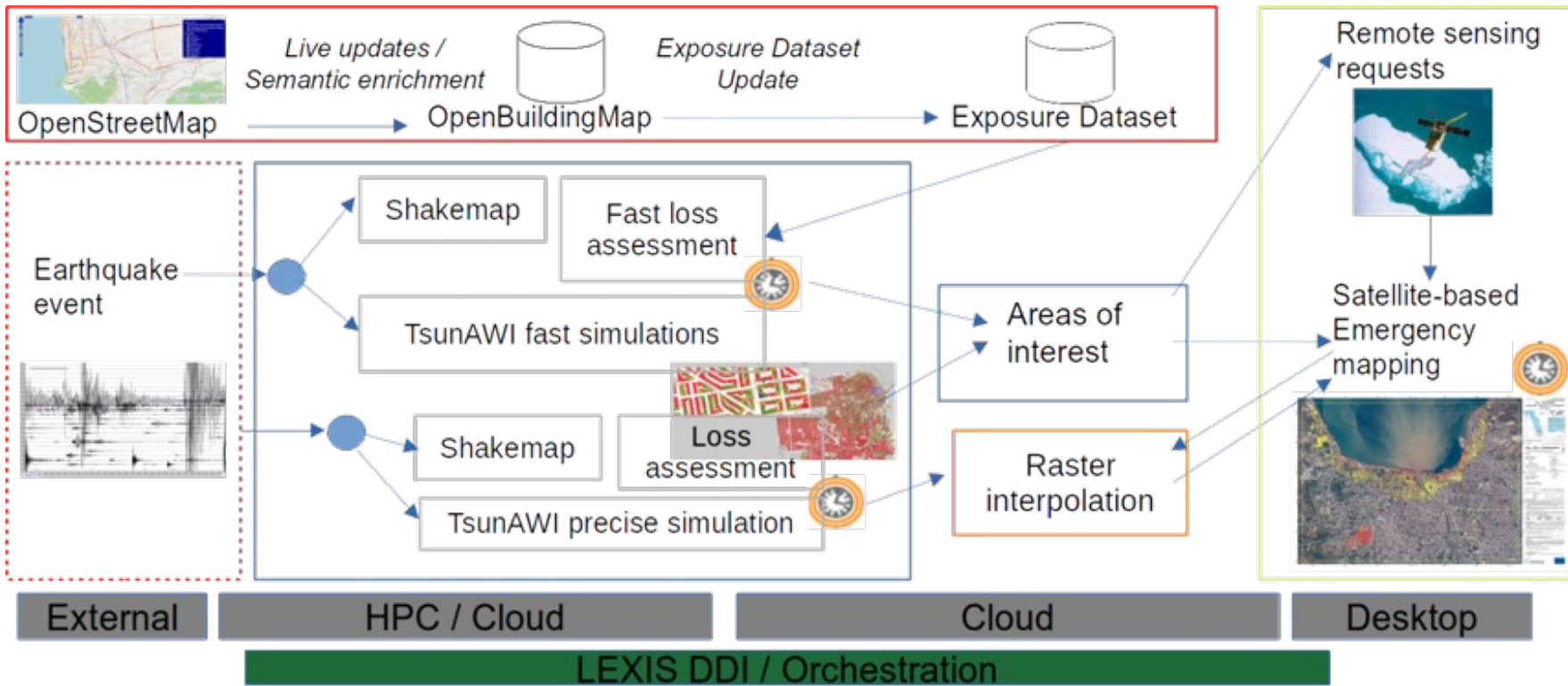
- Resilient long-term computational jobs across several HPC centres
- Easy use by unified access layer
- Easy access to accelerated visualization of simulation results which is a part of this pilot workflow
- **Investigation of the industrial applicability of the newly designed HPC/Cloud/BD platform**
- **Porting of an adopted software code from an only CPU-based version to a GPU-accelerated one**
- Implementation of a newly developed CFD methodology to predict and simulate with increasing accuracy a flow field operating inside aviation gearboxes



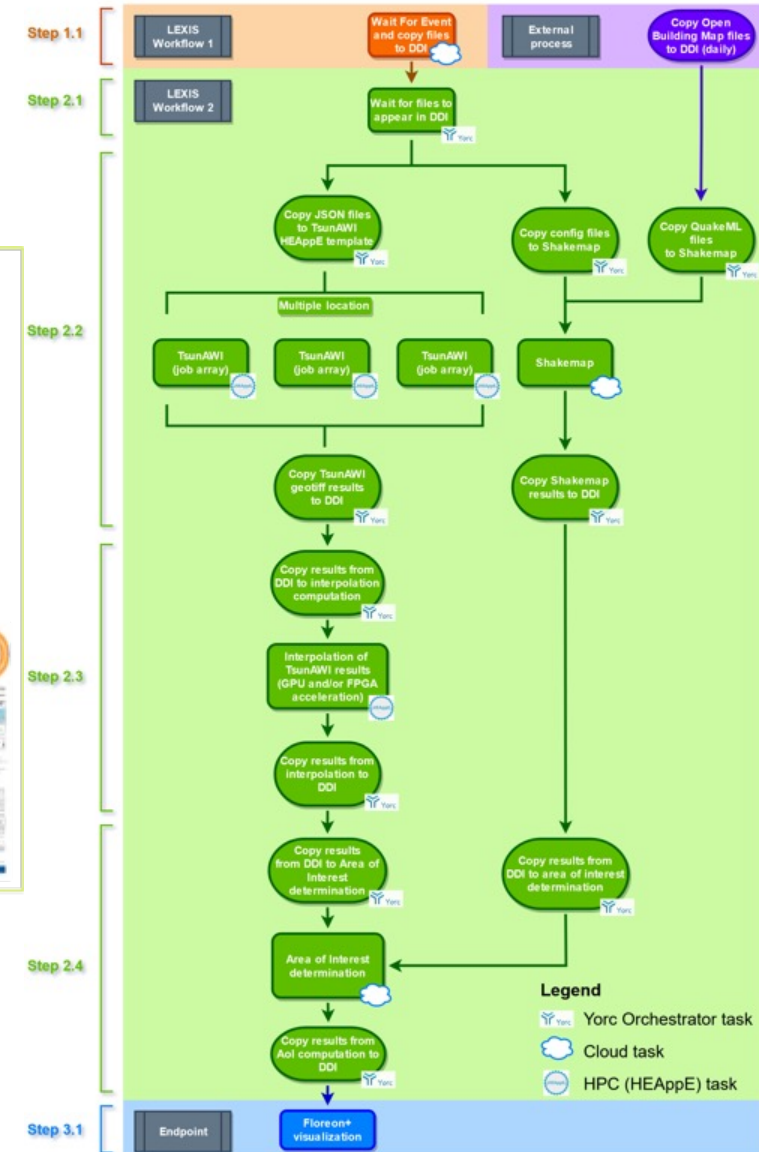
Legend

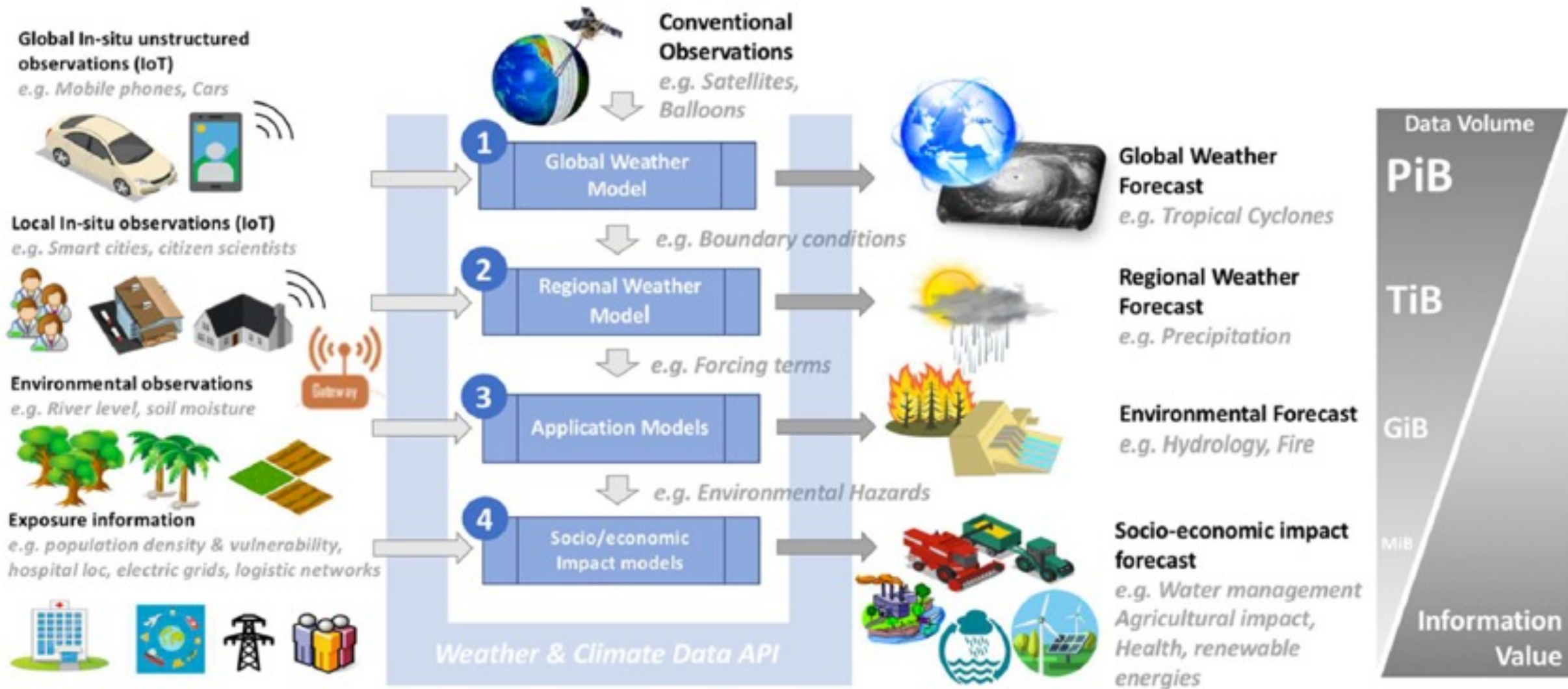
- Yorc Orchestrator task
- HPC (HEAppE) task
- Cloud task
- User interaction

- Event-driven automatized execution of urgent computing complex workflow infrastructure
- Event-triggered, deadline-dependent simulations for short-term forecasts
- Near-real time analysis



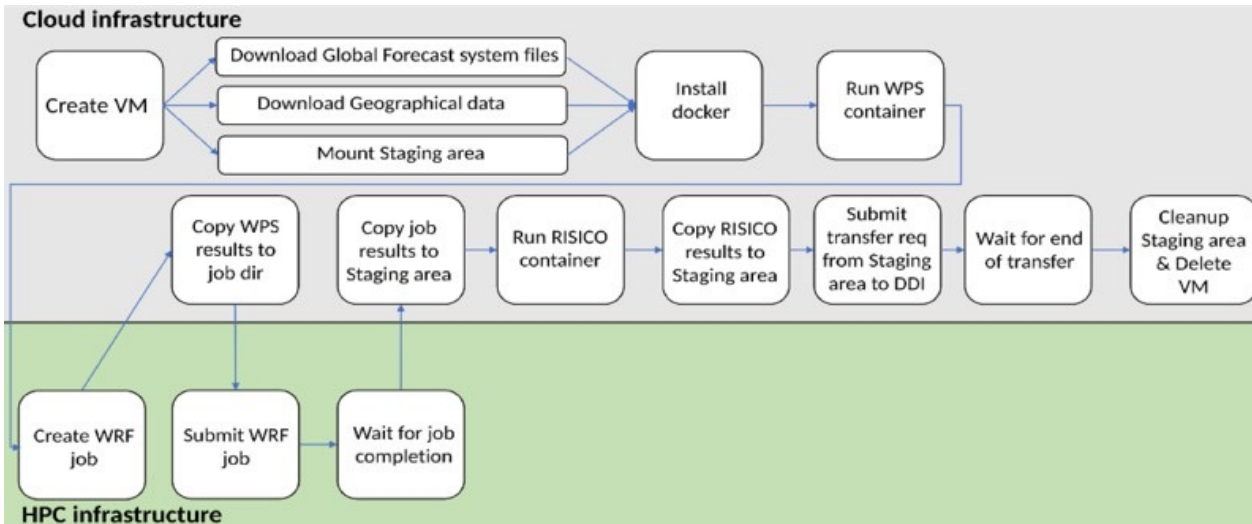
WP6 Urgent workflow path upon earthquake event reception





- **Naturally “hybrid” (Cloud-HPC) workflows**
 - Preprocessing of initial/boundary data
 - High-Resolution HPC regional weather model (WRF)
 - Application simulations using WRF data
 - forest fire risk, hydrological risk / flash-flood prediction

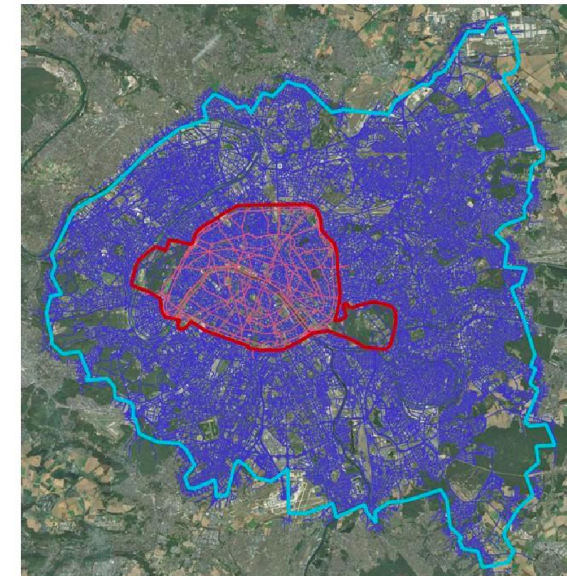
- **Enhanced, data-aware weather & climate workflow orchestration**
 - Urgent simulations when one computing centre is unavailable
 - Large-scale data assimilation (e.g. from sensor networks) for better prediction
 - Distributed data management solution
 - Specialised - Weather and Climate Data API
 - General - Distributed Data Infrastructure



BEFORE LEXIS: red

Area: 106 km²
 Roads: 3 489
 Others sources: 837
 Output points: 80 674

Sub-domains to run: 13

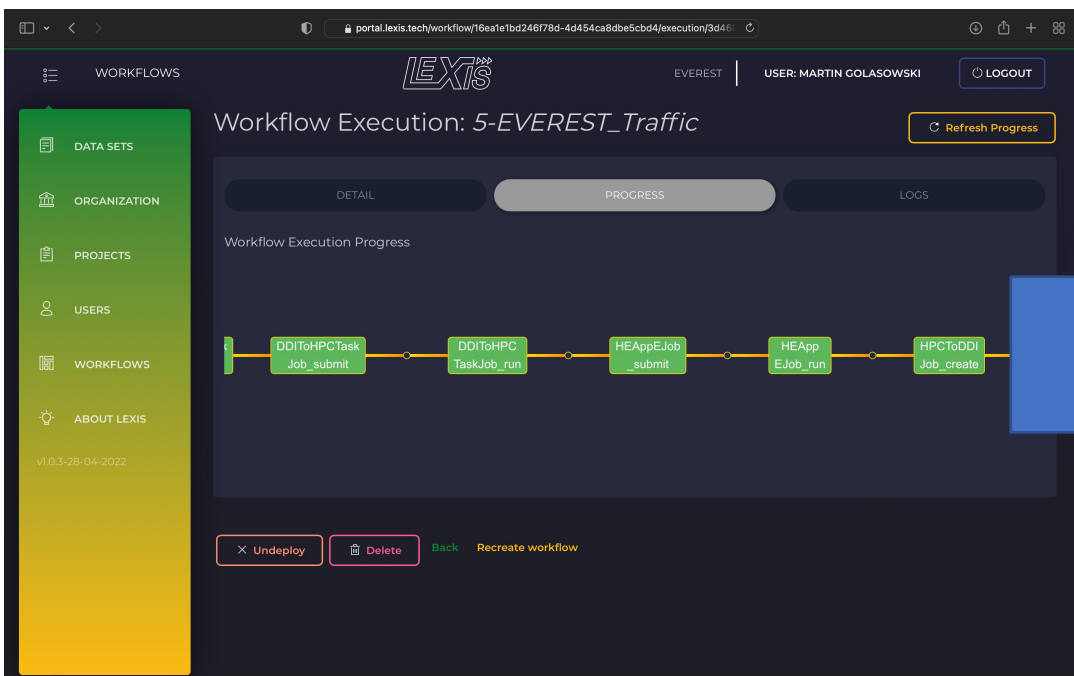


WITH LEXIS: Blue

Area: 772 km²
 Roads: 75 883
 Others sources: 4 000
 Output points: 950 000

Sub-domains to run: 160

Web based UI



Well-defined REST APIs

workflowManagement Actions relating to management of Workflows and Workflow Executions

GET	/workflow	Return list of available LEXIS Workflows	getWorkflows
POST	/workflow	Create a new LEXIS Workflow on the system	createWorkflow
GET	/workflow/{workflowId}	Return detailed info on LEXIS Workflow for given Workflow ID	getWorkflow
DELETE	/workflow/{workflowId}	Delete LEXIS Workflow on the system	DeleteWorkflow
GET	/workflow/{workflowId}/execution	List the current available LEXIS Workflow Executions.	listWorkflowExecutions
POST	/workflow/{workflowId}/execution	TODO: Needs implemented with TOSCA 1.3 Capabilitise. Create a new LEXIS Workflow Execution by providing remaining inputs	createWorkflowExecution
GET	/workflow/{workflowId}/execution/{workflowExecutionId}	Returns LEXIS Workflow Execution detail.	getWorkflowExecutionDetail
DELETE	/workflow/{workflowId}/execution/{workflowExecutionId}	Cancel a LEXIS Workflow Execution.	cancelWorkflowExecution

The screenshot shows the 'Workflow Execution: LEXIS_WFE_1' interface. It features a sidebar with navigation options: DATA SETS, ORGANIZATION, PROJECTS, USERS, WORKFLOWS, and ABOUT LEXIS (v1.0.1 PROTOTYPE). The main area has tabs for 'DETAIL', 'TASK STATUS', and 'LOGS'. Under 'TASK STATUS', the 'Workflow Execution Steps Status' is shown as a flowchart with steps: TRAF_submit, TRAF_run, Turbomachinery VM_install, CreateVisualization Dir_start, CopyFrom Job_start, and Xrv_create. A tooltip for the 'TRAF_run' step provides the following details:

Step	TRAF_run
Status	COMPLETED_SUCCESSFULL
Task	computation
Node name	TRAF
Activity type	CallOperation

- **ALL-IN-ONE WEB INTERFACE**
 - Manage client organization
 - Manage projects
 - Provision and execute application workflows
 - Manage data
 - Interact with large 2D and 3D results remotely in real time

The screenshot shows the 'Project: LEXIS Earthquake and tsunami pilot project' details. It includes a table of project information, a pie chart for resource usage, and a 'Resources Requests' table.

Project:	LEXIS_ID_1
Status:	PENDING
Project manager (email):	abcl@code.com
Core hours:	48,000
Price (euro):	50000
Created by:	engineer@vab.cz
Created at:	31/01/2020, 05:07:39
Updated at:	17/02/2020
Expiration:	31/01/2022
Domain:	Weather forecast

Available/spent core hours:

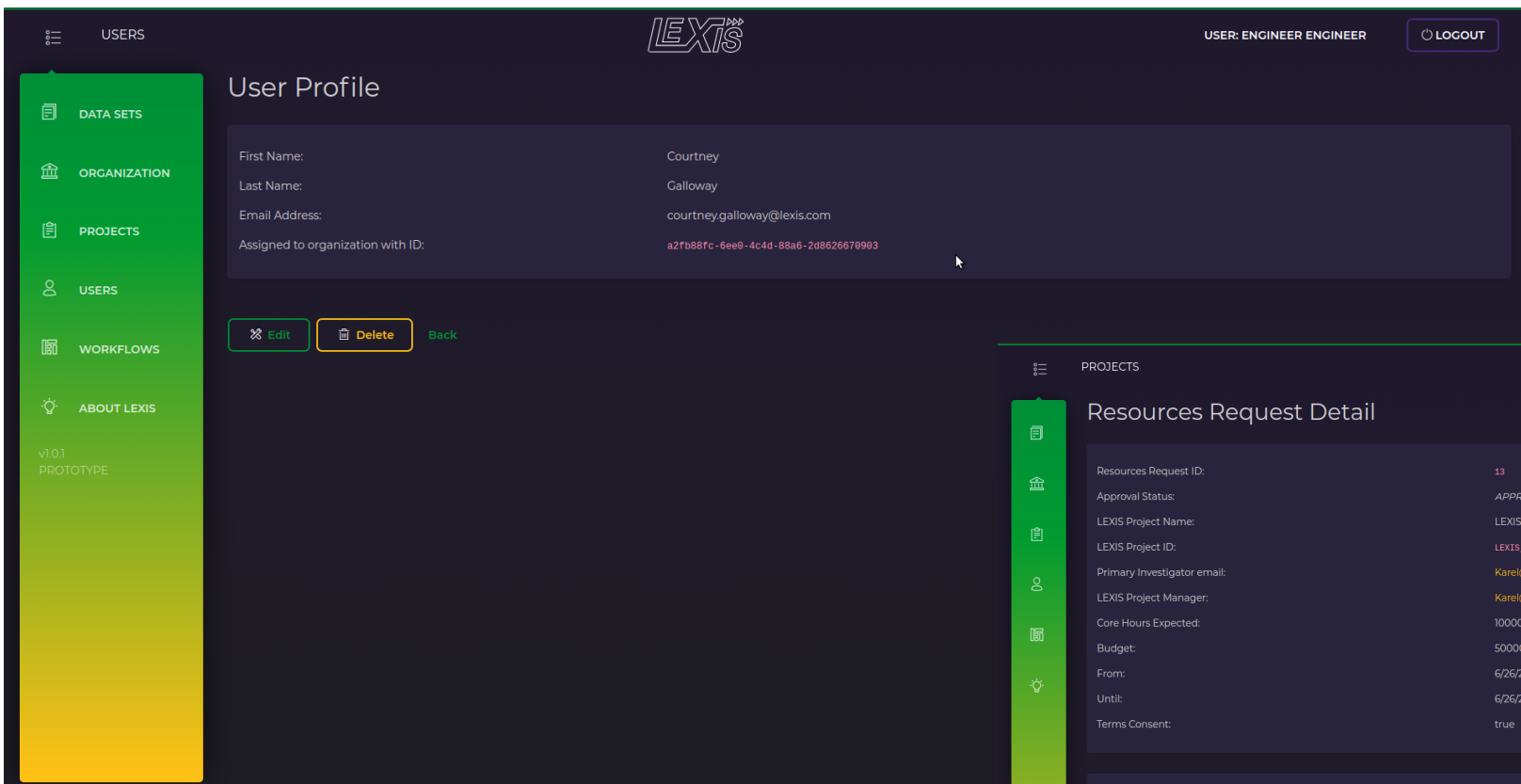
Spent	28,921
Available	19,079

Resources Requests:

ID	STATUS	CLUSTER NAME(S)	QUEUES IDS	NORM. CORE HOURS
----	--------	-----------------	------------	------------------

Interactive 3D visualization (HTML5)
avoiding costly and unsafe transfers
of large computing result data

The screenshot displays the LEXIS Portal interface. On the left, a sidebar contains 'DATA SETS', 'ORGANIZATION', and 'PROJECTS'. The top navigation bar shows 'WORKFLOWS', the 'LEXIS' logo, 'USER: ENGINEER ENGINEER', and a 'LOGOUT' button. The main content area features a 'ParaView 4.4.0 64-bit' window. The 'Pipeline Browser' shows a 'builtin: xyz.xyz' pipeline. The 'Properties' panel is set to 'Information' and shows 'Q File Name' as '/turbo/q.dat'. The 'RenderView1' window displays a 3D visualization of a turbine component with a pressure color scale ranging from -4.892e-01 to 1.000e+00. The interface also includes a 'Pipeline Browser' and a 'Properties' panel for the selected pipeline.



USERS

LEXIS

USER: ENGINEER ENGINEER [LOGOUT](#)

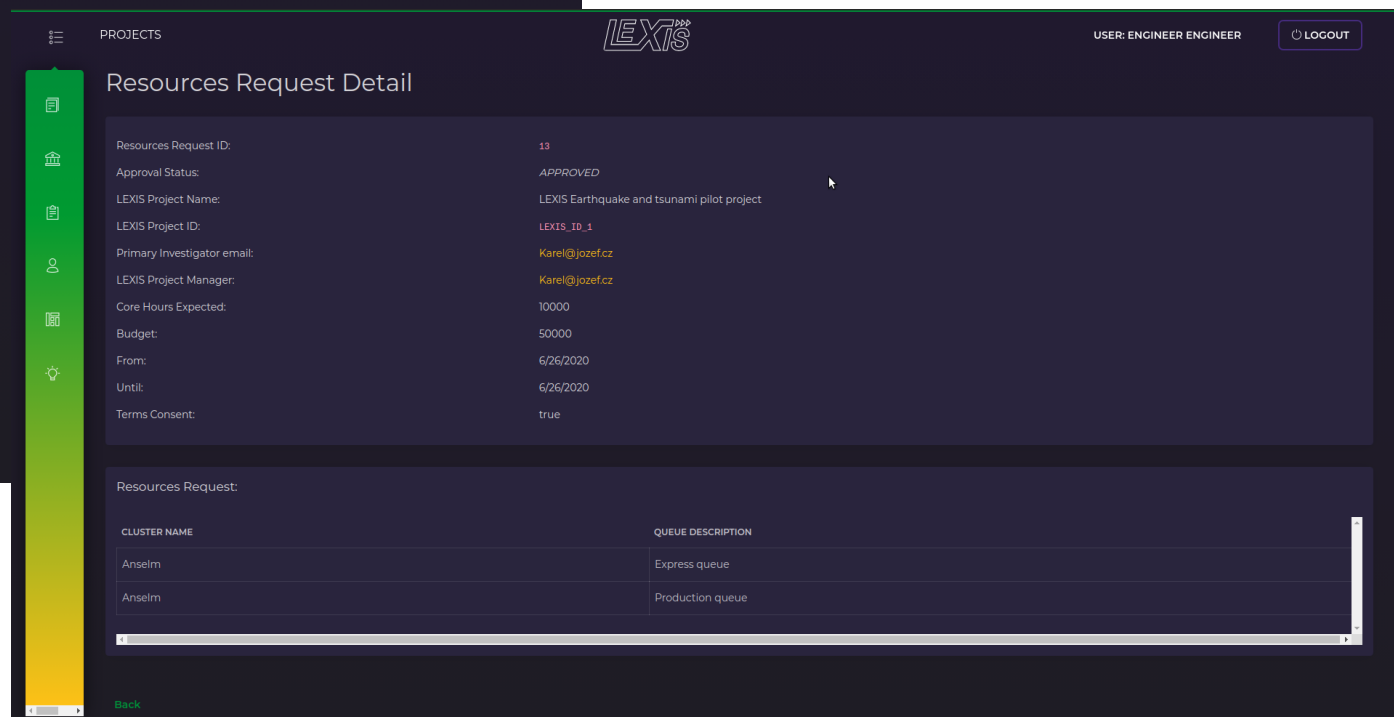
User Profile

First Name: Courtney
 Last Name: Galloway
 Email Address: courtney.galloway@lexis.com
 Assigned to organization with ID: a2fb88fc-6ee0-4c4d-88a6-2d8626670903

[Edit](#) [Delete](#) [Back](#)

DATA SETS
 ORGANIZATION
 PROJECTS
 USERS
 WORKFLOWS
 ABOUT LEXIS

v1.01
 PROTOTYPE



PROJECTS

LEXIS

USER: ENGINEER ENGINEER [LOGOUT](#)

Resources Request Detail

Resources Request ID: 13
 Approval Status: APPROVED
 LEXIS Project Name: LEXIS Earthquake and tsunami pilot project
 LEXIS Project ID: LEXIS_10_1
 Primary Investigator email: Karel@jozef.cz
 LEXIS Project Manager: Karel@jozef.cz
 Core Hours Expected: 10000
 Budget: 50000
 From: 6/26/2020
 Until: 6/26/2020
 Terms Consent: true

Resources Request:

CLUSTER NAME	QUEUE DESCRIPTION
Anselm	Express queue
Anselm	Production queue

[Back](#)

THANK YOU!

CONTACTS

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martin.golasowski@vsb.cz