Large-scale EXecution for Industry & Society

HPC-CLOUD-BIG DATA CONVERGENT ARCHITECTURES + RESEARCH DATA MANAGEMENT: THE LEXIS APPROACH

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

Aeronautics

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

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
PLATFORM AND ORCHESTRATION
USER EXPERIENCE

LEXIS portal
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
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://heapp.e.eu
TERMINOLOGY – USER VIEW VS. TECHNOLOGY VIEW
LEXIS DATA SYSTEM
(DISTRIBUTED DATA INFRASTRUCTURE – DDI)
LEXIS DISTRIBUTED DATA INFRASTRUCTURE

Functionality in LEXIS ecosystem

**Portal and Orchestrator**

- Data Search API
- Data Staging API

**Monitoring System**

- Monitoring/Billing API

**DDI**

(Distributed Data Infrastructure with Metadata Handling / FAIR)

**Local Storage Systems**

**AAI**

(Authentication & Authorization Infrastructure)
LEXIS DISTRIBUTED DATA INFRASTRUCTURE

Backend functionality in more detail

HPC 
Cloud

iRODS/iCAT Servers LRZ (redundant)

LRZ: „DSS“ IBM Spectrum Scale/GPFS

LRZLexisZone

EUDAT/B2SAFE

HPC 
Cloud

iRODS/iCAT Servers IT4I (redundant)

IT4I: CEPH Storage
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

Handle.Net®
Handle Values for: 1001/5a4948de-ee65-11e9-89b5-0050568f8e43

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## LEXIS INTEGRATION WITH REST APIS: STAGING API

### Overview of the Staging API

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<th>Endpoint</th>
<th>Method</th>
<th>Request body</th>
<th>Response body</th>
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<tr>
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<td>{&quot;request_id&quot;: &quot;cc19e4a8-e4cf-4bca-bf7a-2bc9a27c44d6&quot;}</td>
</tr>
<tr>
<td>/stage/&lt;request_id&gt;</td>
<td>GET</td>
<td>-</td>
<td>{&quot;status&quot;: &quot;Transfer completed&quot; }or { &quot;status&quot;: &quot;In progress&quot; }</td>
</tr>
<tr>
<td>/delete</td>
<td>DELETE</td>
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<tr>
<td>/delete/&lt;request_id&gt;</td>
<td>GET</td>
<td>-</td>
<td>{&quot;status&quot;: &quot;Data deleted&quot; }or { &quot;status&quot;: &quot;In progress&quot; }</td>
</tr>
</tbody>
</table>
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 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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CONSORTIUM

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