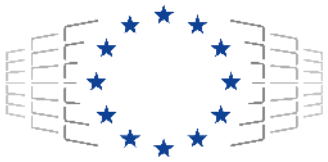
IO-SEA Hackathon

Hands-On Training with Data Access & Storage Interface (DASI)



EuroHPC
Joint Undertaking

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Outline

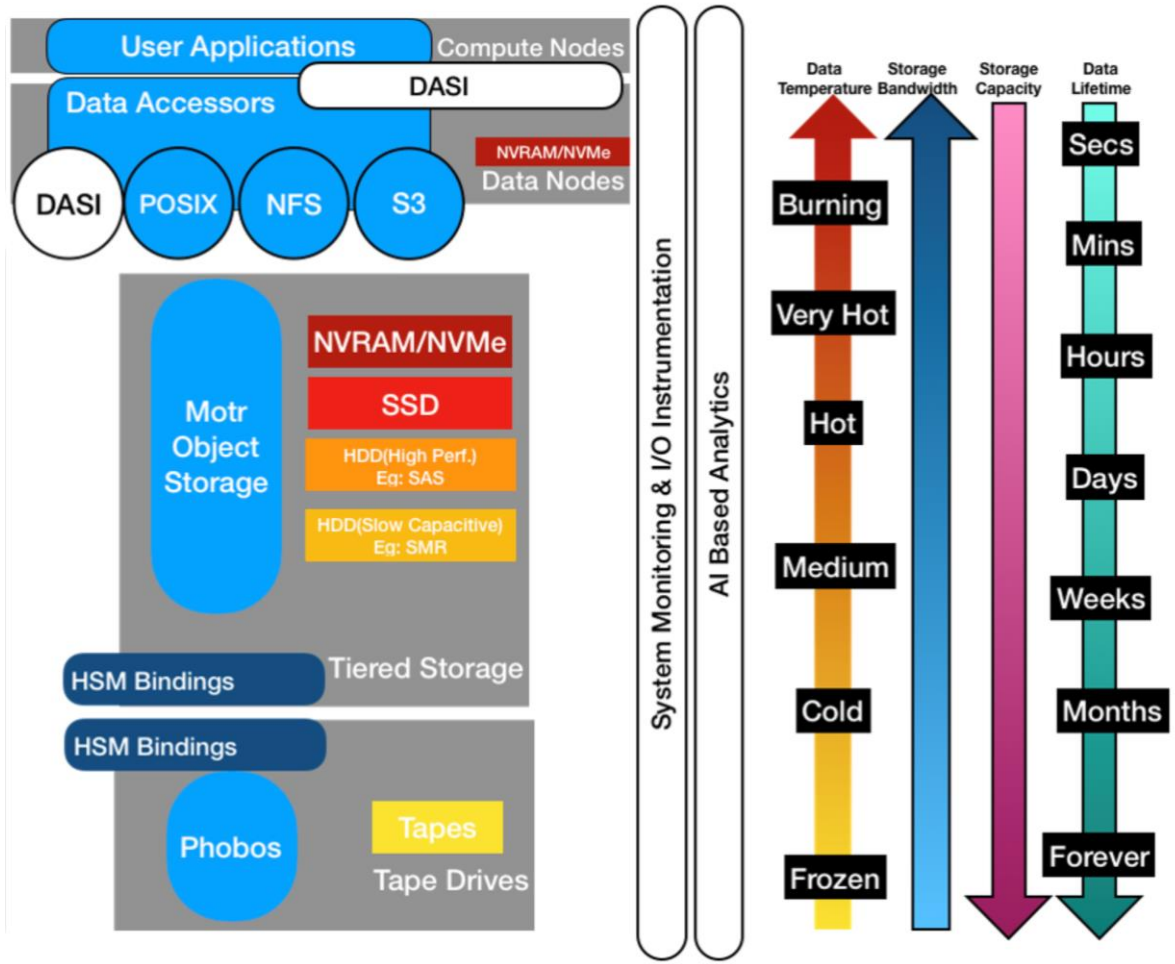
- IO-SEA Project
- DASI Concept and Design
- API

IO-SEA Project

- **Aim:** to implement solutions for scaling I/O intensive applications to exascale HPC systems

- **Components:**
  - Object stores
  - Hierarchical storage management (HSM)
  - Ephemeral services

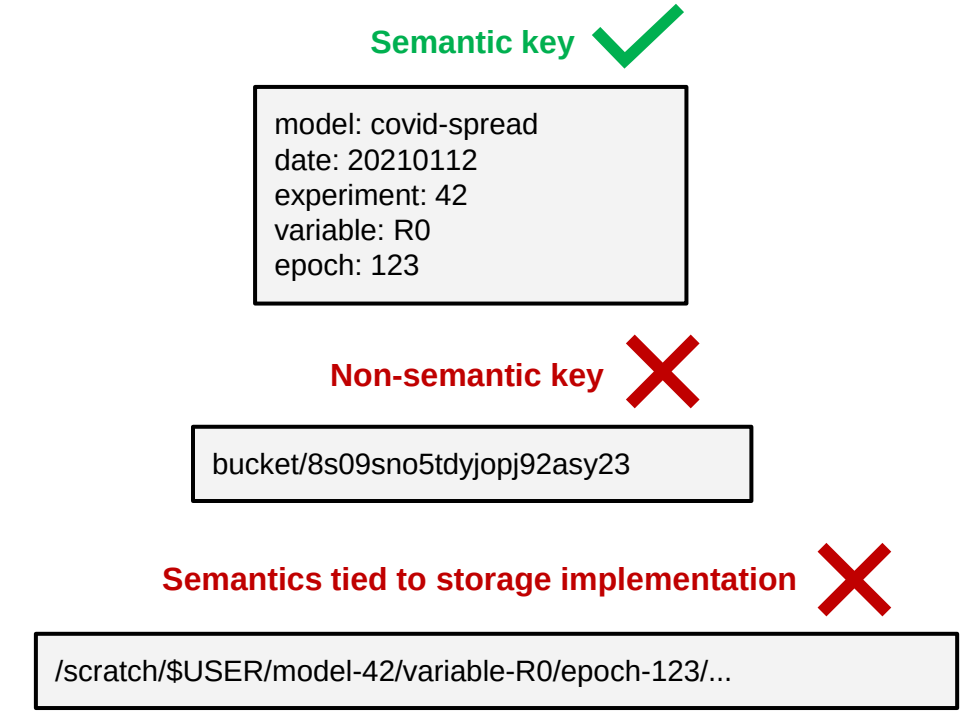
- **DASI** sits between the user applications and HSM as an application interface for abstracting the complex storage layer from users



DASI Concept and Design

DASI Concept

- **Data Access and Storage Interface (DASI)** provides a scientifically meaningful way to manage data, and abstracts the underlying storage technologies
- **The key used to index data is a semantic description of the data**
  - Not just a UUID
  - The metadata is used to index and uniquely identify the data
  - Ensures data is findable and accessible
  - Domain-specific schemas of allowed keys are defined by configuration



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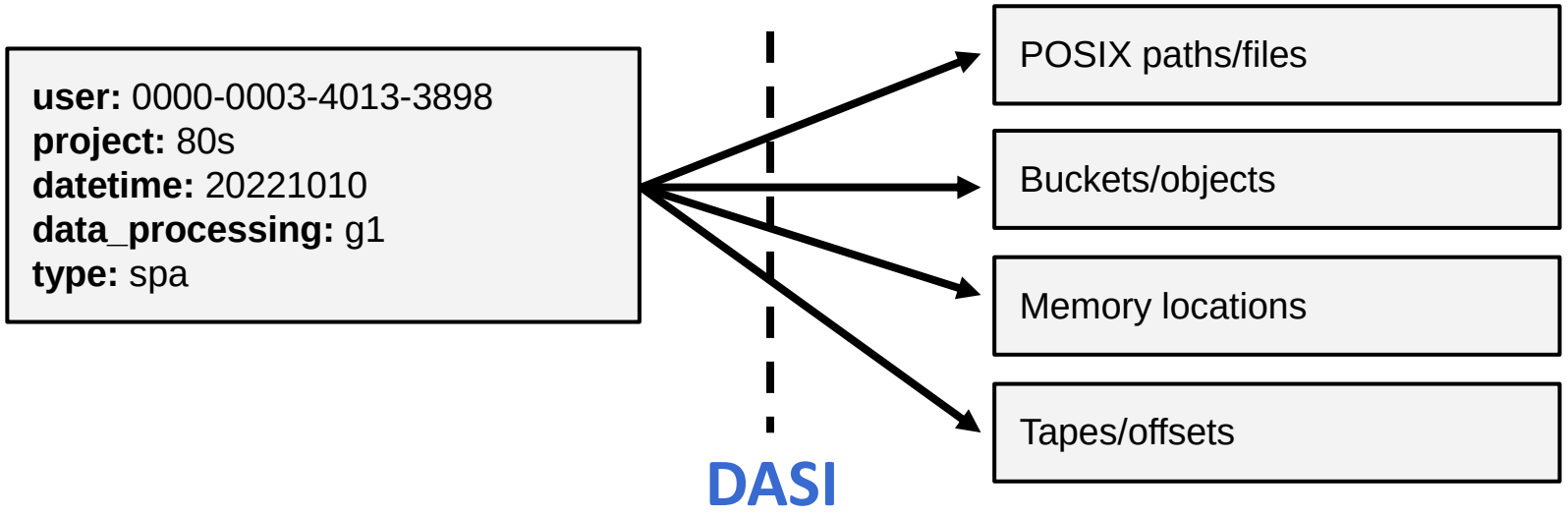
Semantic Data Access as an Abstraction

- You have probably already done basic semantic data access with files and folders…

```
/../0000-0003-4013-3898/80s/20221010/g1/spa/...
```

… but a better implementation decouples the scientific identification from the storage resource



… and the applications don't need to care how the objects are stored

- Allows optimal usage of storage backend without leaking details to user-space

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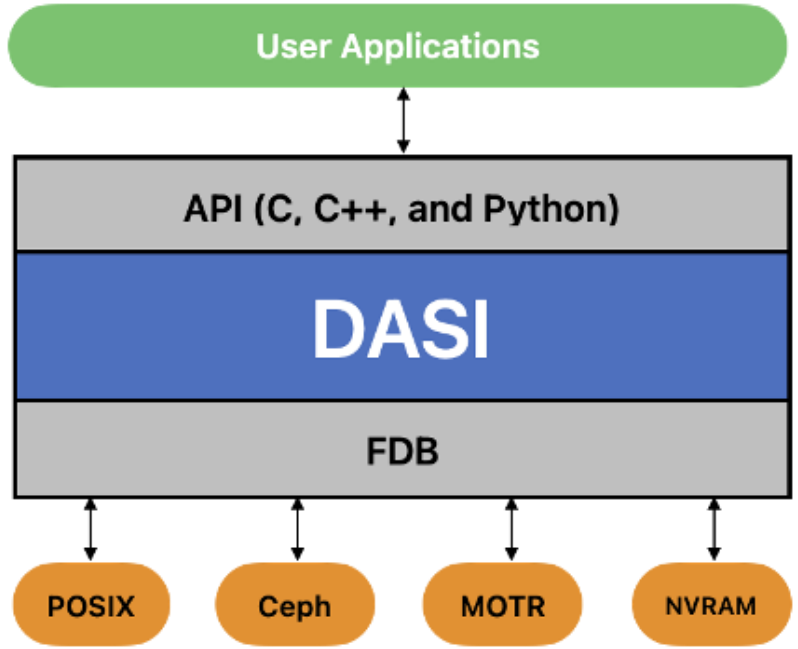
DASI Design

- **DASI API**
  - Frontend abstraction
  - Could allow directly implementing POSIX-like frontend
- **DASI Core**
  - Converts requests into indexable identifiers
  - Expands query requests (ranges, wildcards, etc.)
- **DASI Index Abstraction**
  - Mapping between keys and object locations in datastore
- **DASI Datastore Abstraction**
  - Object-store-like API for raw storage objects



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DASI API and Usage

Implementation of DASI

- **DASI APIs Available**
  - C
  - C++
  - Python
  - Command Line Interface (CLI)
- **Configured through Collection Schemas**
  - Specify the semantic keys
  - Hierarchy of metadata keys
  - Each collection schema is a tree with three levels
- Data is addressed by specifying all the keys along a path from the root to a leaf

Example Schema

```
[ User, Project,
  [ Date, Time
    [Processing],
  ],
]
```

Example Address

```
User: jw
Project: IOSEA
Date: 20231101
Time: 12
Processing: training
```

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Building a Schema

- **Identify Data Collection**
  - Which data do you want to store together?
  - What are your data objects?
- **Define Metadata keys**
  - How do you uniquely identify an object?
  - If needed, what are the different sets of keywords need?
- **Determine Hierarchy**
  - Choose relevant order for the keywords
  - Schema supports branching

```
Example: Cryo Electron
Microscropy
```

```
Keywords: User, Project,
Date, Time, Processing, Type
```

```
Hierarchy:
1. User, Project
2. Date, Time
3. Processing, Type
```

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Example Schema

```
# Rule 1
[ User, Project,       # Level 1: specifies top level directory
  [ Date, Time,        # Level 2: specifies filename
    [Processing],      # Level 3: indexes entries in file
  ],
]

# Rule 2
[ Institute, Project,
  [ Date, Location?,   # “?” used for optional key
    [Type],
  ]
]
```

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DASI Python API

```
dasi = Dasi(“config.yaml”) # location of schema file defined in config.yaml

# Save some data (bytestream) using associated metadata (key)
key = {“User”: “jw”, “Project”: “IOSEA”, “Date”: “20231101”, “Location”: “Reading”}
dasi.archive(key, data)

# Retrieve saved data
data = dasi.retrieve({User:{jw}, Project:{IOSEA}, Date:{20231101}, Location:{Reading}) ➔ [bytestream]

# Use list to query data stored in Dasi
dasi.list(({User:{jw}, Date: {20231101}}) ➔ [metadata]
```

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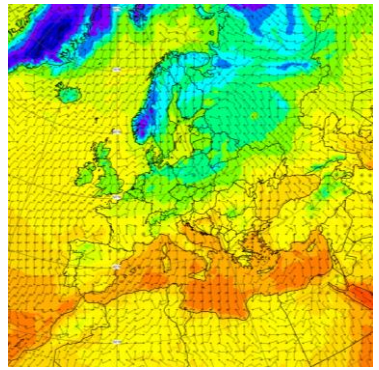
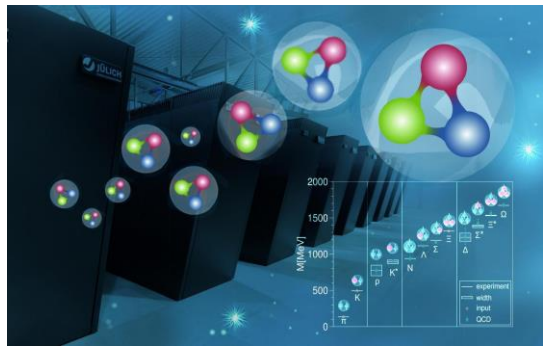
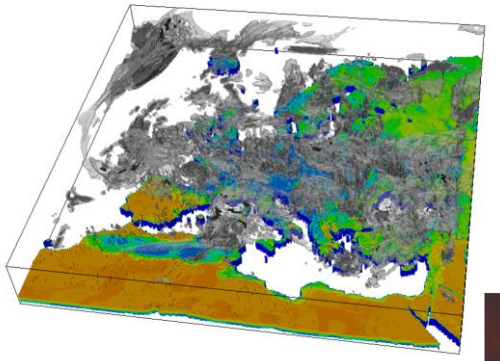
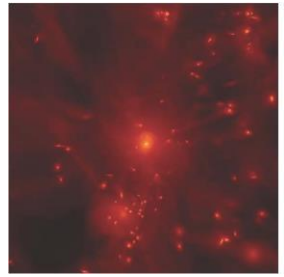
IO-SEA Use Cases

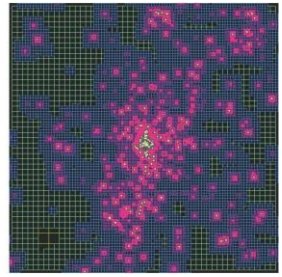
- **ECMWF** uses DASI for Integrated Forecast System weather forecasting workflow
- **Lattice Quantum Chromodynamics** uses DASI for markov-chain scientific checkpoint files
- **Terrestrial Systems Multiple-Physics** (TSMP) uses DASI for output from TSMP model components
- **RAMSES** code for modelling astrophysical phenomena uses DASI for post-processing
- **CEITEC** electron microscopy facility DASI for raw imagery and processed images

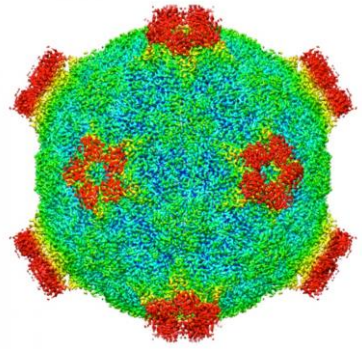












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