Ongoing Activity: Earth-Science Data Middleware

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- Part of the ESiWACE Center of Excellence in H2020
  - Centre of Excellence in Simulation of Weather and Climate in Europe
- ESiWACE2 follow up has been funded!

ESDM provides a transitional approach towards a vision for I/O addressing

- Scalable data management practice
- The inhomogeneous storage stack
- Suboptimal performance & performance portability
- Data conversion/merging

Earth-System Data Middleware

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Design Goals of the Earth-System Data Middleware

1. Relaxed access semantics, tailored to scientific data generation
   - Avoid false sharing (of data blocks) in the write-path
   - Understand application data structures and scientific metadata
   - Reduce penalties of **shared** file access
2. Site-specific (optimized) data layout schemes
   - Based on site-configuration and performance model
   - Site-admin/project group defines mapping
   - Flexible mapping of data to multiple storage backends
   - Exploiting backends in the storage landscape
3. Ease of use and deployment particularly configuration
4. Enable a configurable namespace based on scientific metadata

Architecture

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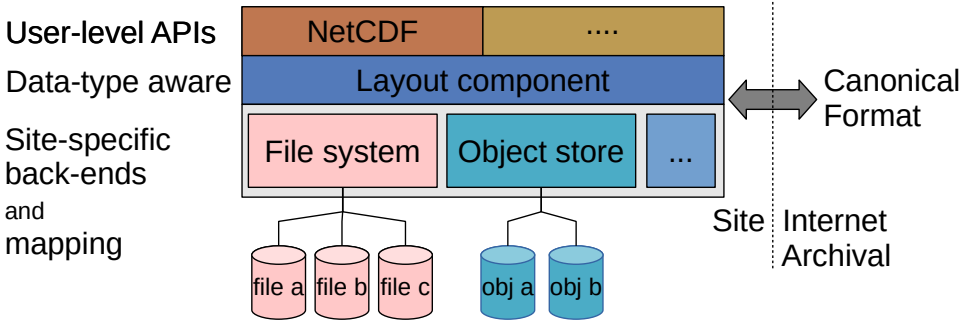
Key Concepts

- Middleware utilizes layout component to make placement decisions
- Applications work through existing API (currently: NetCDF library)
- Data is then written/read efficiently; potential for optimization inside library



ESDM is just the Beginning: Next Generation Interfaces

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Towards a new I/O stack considering:

- User metadata and workflows as first-class citizens
- Smart hardware and software components
- Liquid-Computing: Smart-placement of computing
  - Utilizing arbitrary compute and storage technology!
- Self-aware instead of unconscious
- Improving over time (self-learning, hardware upgrades)

Why do we need a new domain-independent API?

- Other domains have similar issues
- It is a hard problem approached by countless approaches
- Harness RD&E effort across domains

Challenges in the Domain of climate/weather

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- High data volume and velocity
- Data management practice does not scale
  - e.g., hierarchical namespaces does not reflect use cases
  - Scientists spend quite some time to define the namespace
- Suboptimal performance (& performance portability) of data formats
  - Tuning for NetCDF, HDF5 and GRIB necessary
  - Scientists worry about interoperability
- Data conversion is often needed
  - Between formats such as NetCDF and GRIB
  - To combine data from multiple experiments, time steps, ...
- External data services to share data in the community
  - (Scientific) metadata is provided by databases

Benefits

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- Expose/access the same data via different APIs
- Independent and lock-free writes from parallel applications
- No fixed storage layout[1]
- Less performance tuning from users needed
- Exploit characteristics of different storage technology
- Multiple layouts of one data structure optimize access patterns
- Flexible namespace (similar to MP3 library)