FENIX - Federated engine for information exchange

Federated data & computing infrastructure

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The Human Brain Project

• Research Communities: The Human Brain Project

Goals of the Human Brain Project (HBP)
- Enable research aiming for understanding of the human brain
- Transfer neuroscience knowledge for development of future technologies

• FET Flagship project funded by EC
- Future & Emerging Technologies projects (co-)funded by European Commission
- Science-driven, seeded from FET, extending beyond ICT
- Ambitious, unifying goal, large-scale

• Current HBP status
- 114 participants in Specific Grant Agreement 1 (SGA1)
- SGA1 runs from 2016-18 with an overall budget of about € 110M
High Performance Analytics & Computing Platform

As part of the HBP, we build and operate a supercomputing, data and visualization infrastructure that enables scientists to

- Run large-scale, data intensive, interactive brain simulations up to the size of a full human brain
- Manage the large amounts of data used and produced in the Human Brain Project
- Manage complex workflows comprising concurrent simulation, data analysis and visualization workloads
The role of FENIX

• Deliver a multi-purpose infrastructure offering scalable compute and data services in a federated manner

• Support new communities
  - Neuroscience (remains a main driver to steer the design of the infrastructure)
  - Materials science
  - Genomics
  - Physical science experiments
  - Others communities with similar requirements

• Supported by national funds and EC through the ICEI Project (Interactive Computing E-Infrastructure)
Rationale behind FENIX

• Variety of data sources
  - Distributed data sources
  - Heterogeneous characteristics

• HPC systems as source and sink of data
  - Scalable model simulations creating data
  - Data processing using advanced data analytics methods

• Aim for data curation, comparative data analysis and for building-up knowledge graphs

Need for infrastructure to facilitate data sharing and high-performance data processing.
Overview of the Fenix Infrastructure
FENIX Services

Specific service targets:
- Interactive Computing Services
- Scalable Computing Services
- Federated Data Services

• Additionally
  - IaaS environments (SW-defined Compute, Storage and Network)
  - Container Services, DB services, Site-local AAI
  - Scalable and Interactive Compute, Visualisation, Dense memory and Storage tiers
  - Active- and Archival-class Storage

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Key challenges

- **Common AAI infrastructure**
  - Federated user identities
  - Single sign-on

- **Federation of storage resources**
  - Scalable vs. federated access

- **Integration of interactive computing resources**
  - New type of resource

- **Management of resource allocation**
  - Different resource classes
  - Delegation of resource allocation to research communities
Key architectural concepts
Interactive Computing Services

• **Interactivity**
  - capability of a system to support distributed computing workloads while permitting
    - Monitoring of applications
    - On-the-fly interruption by the user

• **Architectural requirements**
  - Interactive access
  - Tight integration with scalable compute resources
  - Fast access to data. Improve data movement across multiple storage layers (NVRAM, NVMe, Apache Pass, 3DXPoint, SSD, Disks, Tapes, etc.)

• **Support for interactive user frameworks**
  - Jupyter notebook
  - R
  - Matlab/Octave
Data Store Types

• **Archival Data Repository**
  - Data store optimized for capacity, reliability and availability
  - Used for storing large data products permanently that cannot be easily regenerated

• **Active Data Repository**
  - Data repository localized close to computational or visualization resources
  - Used for storing temporary slave replica of large data objects

• **Upload buffers**
  - Used for keeping temporary copy of large, not easy to reproduce data products, before these are moved to an Archival Data Repository
Architectural Concepts: HPC vs. Cloud

• **State-of-the-art: HPC**
  - Highly-scalable parallel file systems
    • Scale to $O(10)$ clients
    • Optimised for parallel read/write streams
  - Interface(s): POSIX
    • Well established interface
    • Wealth of middleware relying on this interface

• **State-of-the-art: Cloud**
  - Solutions for widely distributed storage resources
    • Optimised for flexibility
  - Various interfaces: Amazon S3, OpenStack Swift
    • Typically web-based stateless interfaces
  - Advantages compared to POSIX
    • Suitable for distributed environments (e.g. support for federated IDs)
    • Simple clients
    • Rich mechanisms for access control
Storage Architecture

• **Concept**
  - Federate archival data repositories with Cloud interfaces
  - Non-federated active data repositories with POSIX interface accessible from HPC nodes

• **Envisaged implementation:**
  Mandate same technology at all sites
  - Current candidate: OpenStack SWIFT
Selected Use Cases

• GUI based interaction with extreme scale network models
  - Various simulators supporting different models
  - Need for interactive visualisation of network generation and simulation

• Enrichment of the human brain atlas with qualitative and quantitative datasets
  - Spatial and semantic registration of diverse datasets to the human brain atlas

• Validation of neuromorphic results
  - Analysis of the similarities and differences of results obtained through simulation on HPC and from neuromorphic systems

https://brainscales.kip.uni-heidelberg.de/
Scalable Computing Services

Scalable computing services are a key element of the Fenix Infrastructure

- **Piz Daint** at CSCS will form a major part of these services
  - A hybrid multi-core system with 7135 nodes
  - >27 PFlop/s aggregate peak
- The Piz Daint environment offers
  - Scalable and Interactive Computing
  - Visualization
  - Dense memory and storage tiers
  - High-throughput Active Storage
  - All within one system
Thank you!
Credits

• **BSC**
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