# Composing HPC Micro-Services to Build Application-Tailored Distributed Object Stores

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# Mochi Project

# Software Defined Storage

DOE project 2015-present

Existing storage systems provide diverse features

- Data distribution
- Indexing methods
- Access semantics
- Transactions and locking
- Fault tolerance, replication

But they are not tailored to each application individually

However, they build on similar components

- RPC mechanism
- Threading/tasking management
- Storage management
- Metadata management
- Group membership

Let's split these building blocks and recompose them according to each application's needs

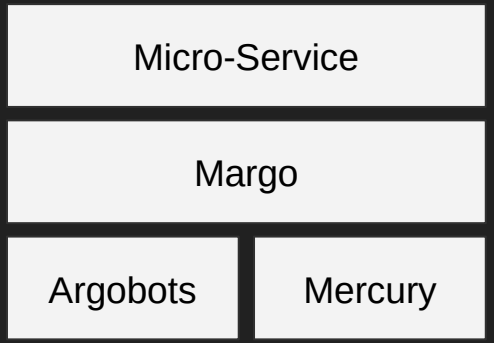
# Composing HPC Microservices

- Formalize composition
- Unify single-process, multi-process, single-node, and multi-node designs
- Maximize efficient use of resources (network, storage)

## Mochi building blocks

- MERCURY: RPC library with RDMA support and many network backends
- ARGOBOTS: Threading/tasking framework
- MARGO: Higher-level, ARGOBOTS-enabled MERCURY interface
- BAKE: RDMA-enabled data transfer to local storage (e.g. SSD, NVRAM)
- SDSKV: Key/Value store backed by LevelDB or BerkeleyDB
- SSG: Scalable Service Groups, group membership management
- MDCS: Lightweight diagnostic component
- PLASMA: Distributed approximate k-NN database
- POESIE: Enables running Python and Lua interpreters in Mochi services
- THALLIUM: C++14 wrapper for Margo
- Python wrappers: Py-Margo, Py-Bake, Py-SDSKV, Py-SSG, Py-Mobject, etc.

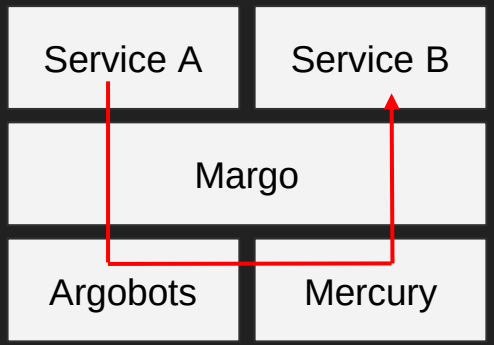
# Mochi micro-services



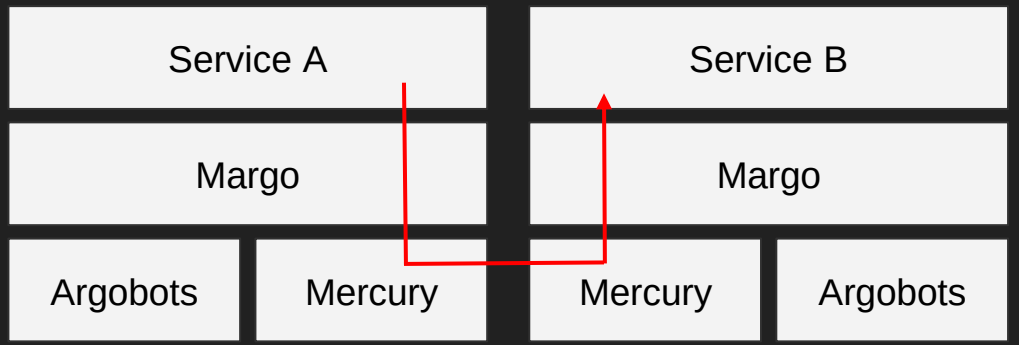

- Mercury: RPC/RDMA
- Argobots: Threading/Tasking
- Margo: Mercury+Argobots

# Different deployments; same code!

In a single node

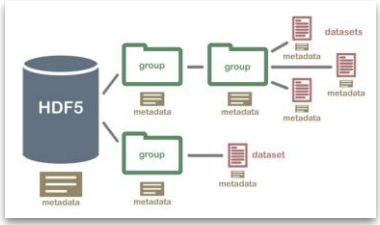


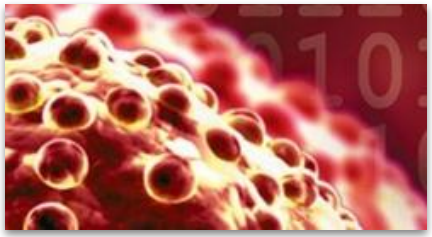

In a distinct nodes



Different users

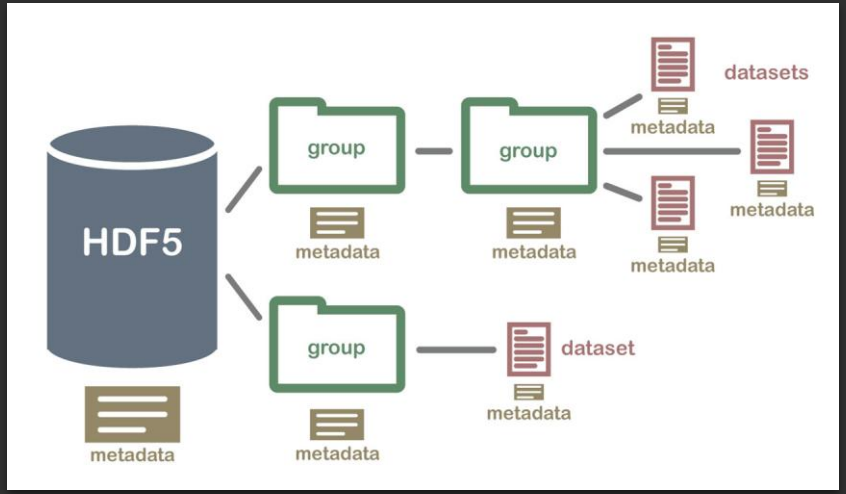
Different needs



# Mobject

From microservices
to object store




The HDF Group

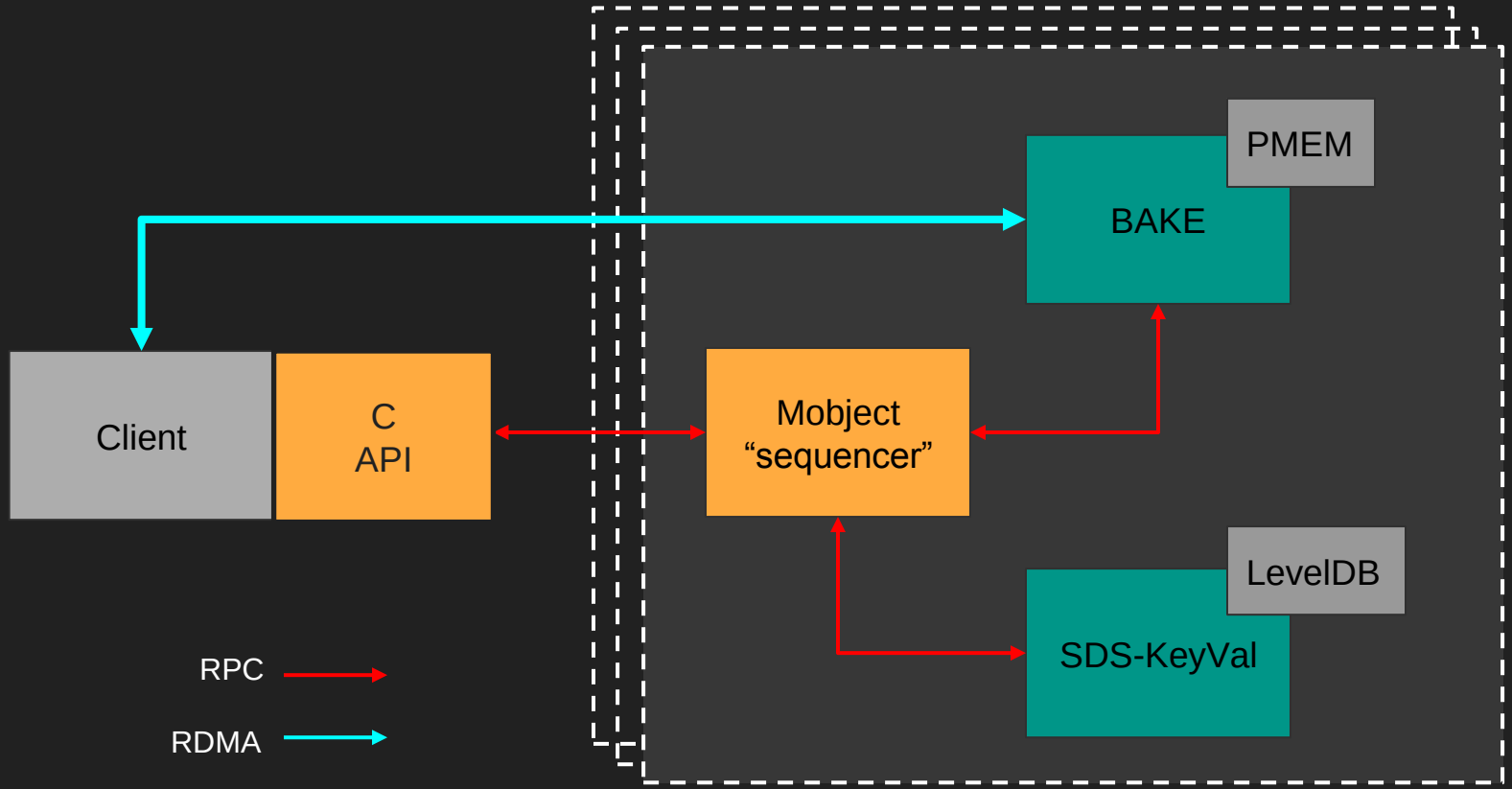
Mobject: from microservices to object store

- Transaction-enabled
- Flat namespace
- RADOS client API

- Components used: MERCURY, ARGOBOTS, MARGO, SDSKV, BAKE SSG

- Extra code: Sequencer, "RADOS-like" API

# Mobject: from microservices to object store



# HEPnOS

Fast event-store for High Energy Physics experiments

Fermilab

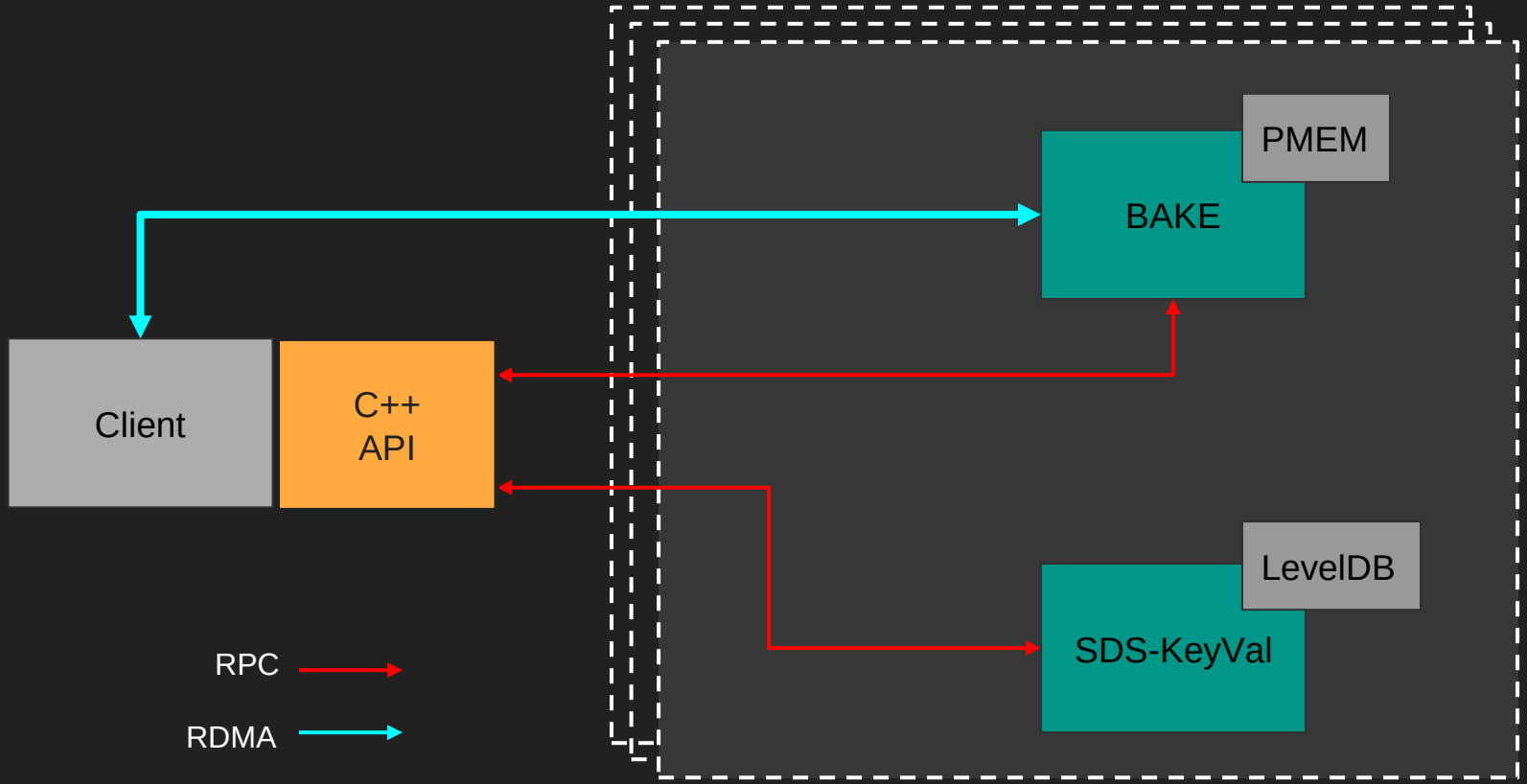
HEPnOS: fast event-store for High-Energy Physics experiments

- Write-once-read-many
- Hierarchical namespace (datasets, runs, subruns)
- C++ API (serialization of C++ objects)

- Components used: MERCURY, ARGOBOTS, MARGO, SDSKV, BAKE, SSG

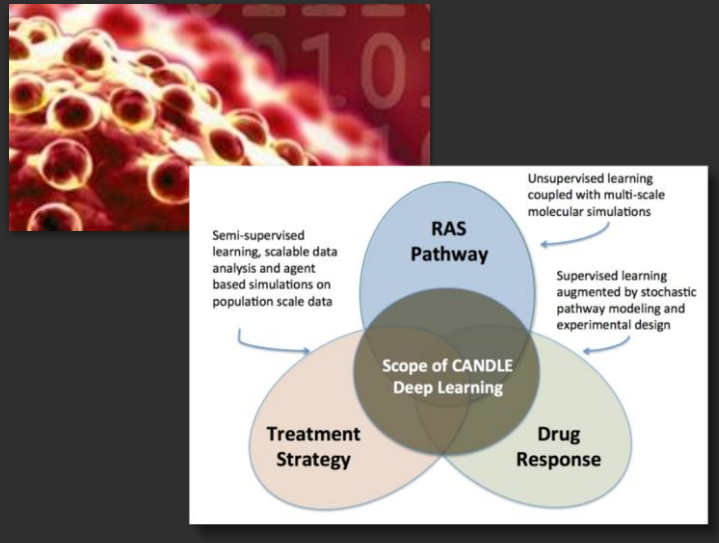
- Extra code: C++ interface

# HEPnOS: fast event-store for High-Energy Physics experiments



# FlameStore

A transient storage system for deep neural networks

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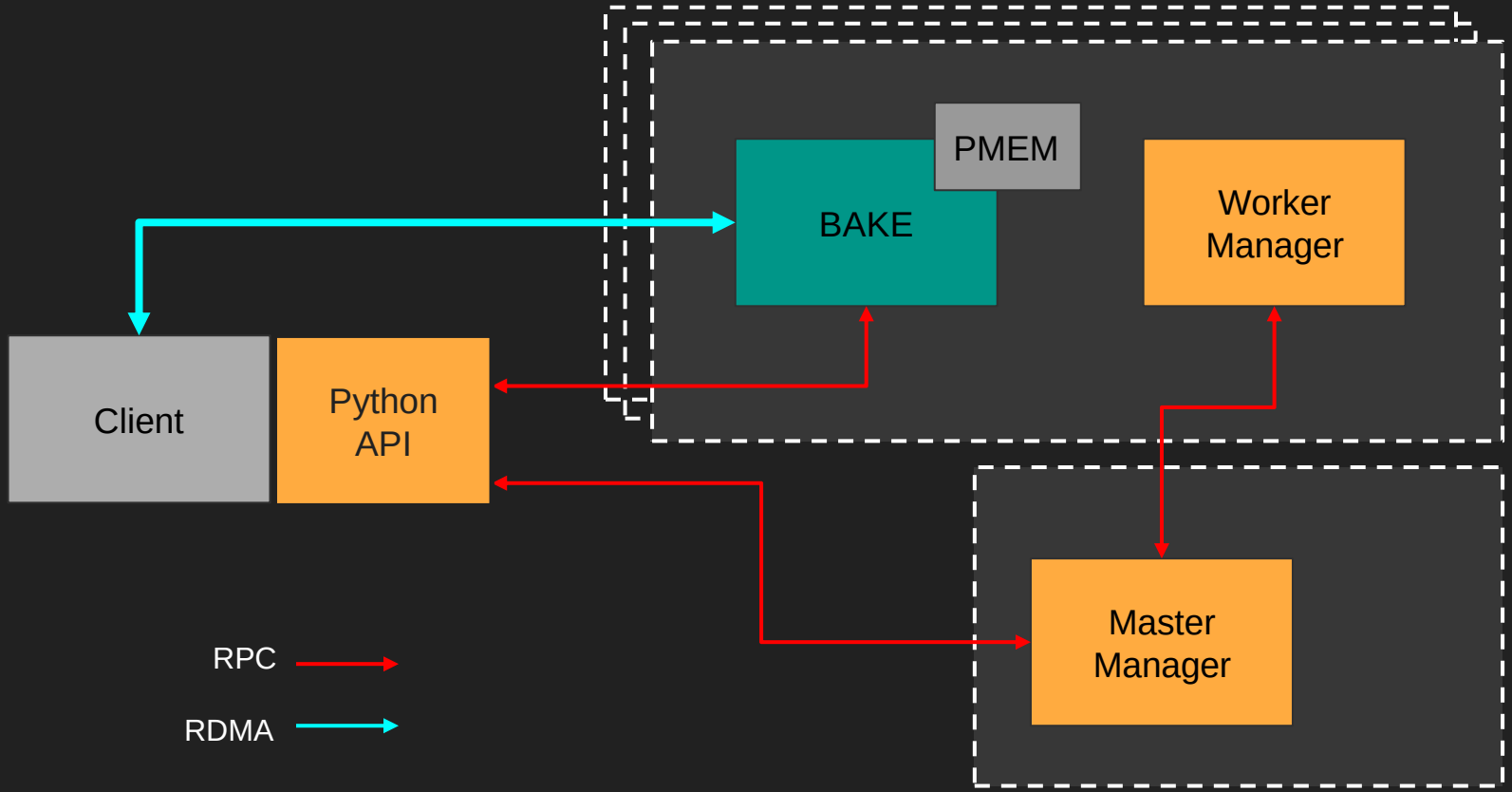
FlameStore: A transient storage system for deep neural networks

- Write-once-read-many
- Flat namespace
- High level of semantics
- Python API (stores Keras models)

- Components used: MERCURY, ARGOBOTS, MARGO, BAKE, POESIE, and their Python wrappers

- Extra code: Python API, master and worker managers

# FlameStore: A transient storage system for deep neural networks



## What we plan to study next

- Deployment and Sharding
  - single vs multiple Key/Value component(s)
  - collocated vs remote components
  - various object sharding policies
- Elasticity/malleability
  - Deploying and shutting down components at run time
  - Migrating components