Characterizing I/O Performance of Computational Simulation Applications

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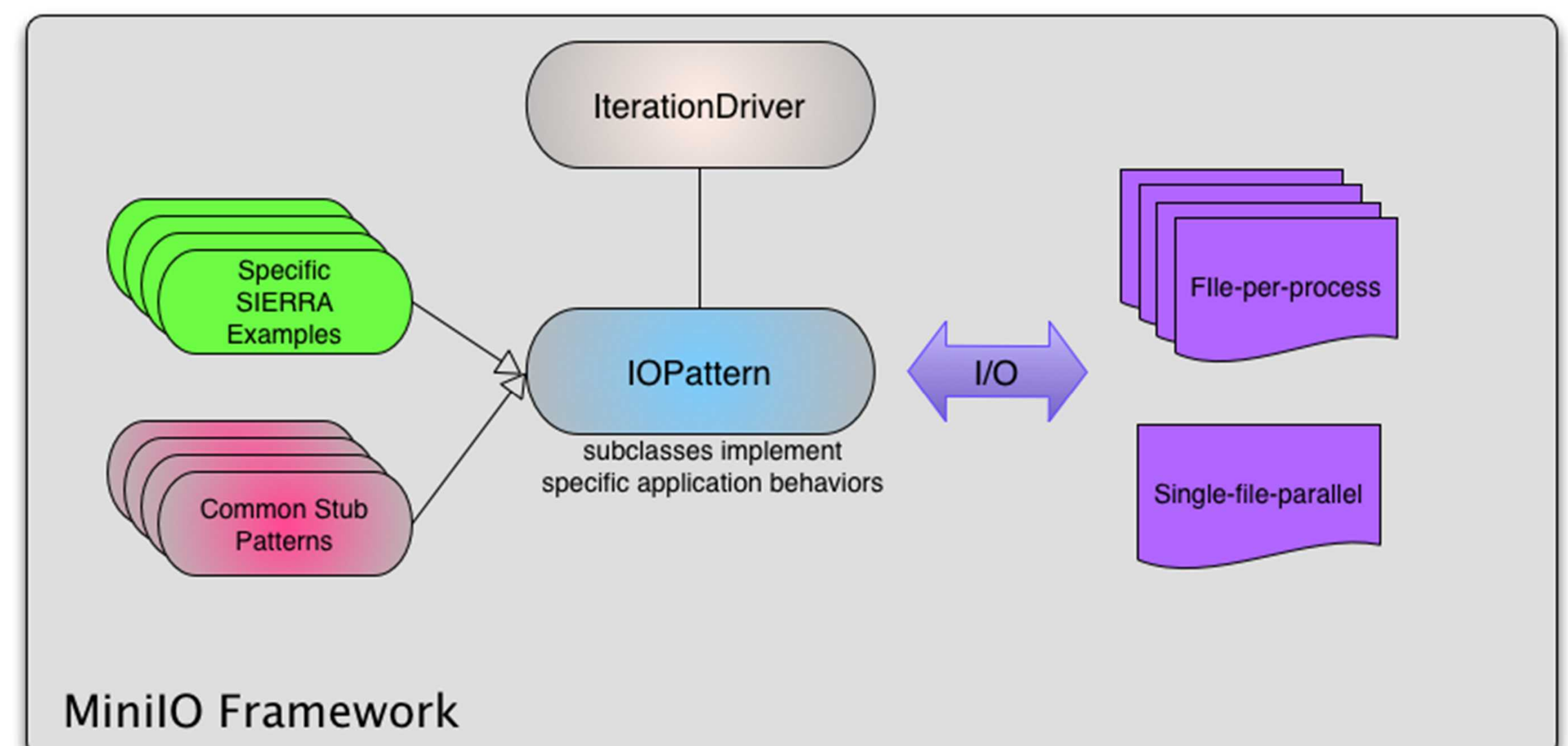Sandia National Laboratories, Albuquerque, New Mexico

Motivation

- *Mini-app* concept as applied to I/O
- Investigating methods to better understand I/O performance characteristics of computational simulations
- Represent I/O behavior of components of SIERRA, Sandia's engineering mechanics simulation code suite
  - Coupled simulation capabilities for thermal, fluid, aerodynamics, solid mechanics, structural dynamics
- Provide guidance for current application deployments
- Help prepare for migrations to future hardware/software platforms

Mesh model I/O

- Initial emphasis on I/O to Exodus II file format
  - Finite element data model, flexible for several computational uses
  - Low-level storage handled by netCDF
  - Developers interact using FE vocabulary (element connectivity, node coordinates, etc)
  - File contents typically include initialization data, static model data, result data
- Result data is organized by timestep
  - Variable categories include nodal, element, nodeset, sideset, global
  - Block groupings used for efficient storage and to minimize I/O
- SIERRA applications use an abstraction layer (IOSS) to access Exodus and other storage formats

Design of MiniIO Framework

MiniIO Framework

- Extensible class hierarchy to add additional application emulations
- Mesh definitions
  - Synthetic and canonical mesh construction and field assembly operations
  - Specific mesh usage examples from SIERRA applications
- Iteration / result update patterns
  - Computation results for visualization or graphics, ~100 timestep interval, involving majority of nodes
  - History (similar to results but usually for small node counts or individual nodes)
  - Per-processor restart files based on wall-clock interval
- Output modes / formats
  - File-per-process, single file parallel
  - In addition to Exodus, potential experimental I/O targets (ATDM/Kelpie) - investigate how to evolve SIERRA apps

Implementation status / plans

- At-scale testing underway now
- Initial Sierra applications chosen for emulation
- Availablility in Q4 2015

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