HEP-CCE: Fine-grained I/O and Storage (IOS) Activities Year 1

Peter van Gemmeren, Rob Ross
People Involved
(sorry if we missed you!)

• High Energy Physics
  • Doug Benjamin (ANL)
  • Paolo Calafiura (LBL)
  • Philippe Canal (FNAL)
  • Oliver Gutsche (FNAL)
  • Salman Habib (ANL)
  • Kenneth Herner (FNAL)
  • Patrick Gartung (FNAL)
  • Lisa Goodenough (FNAL)
  • Christopher Jones (FNAL)
  • Liz Sexton Kennedy (FNAL)
  • Kyle Knoepfel (FNAL)
  • Peter Van Gemmeren (ANL)

• (More) High Energy Physics
  • Tammy Walton (FNAL)
  • Torre Wenaus (BNL)

• Computer Science
  • Suren Byna (LBL)
  • Matthieu Dorier (ANL)
  • Rob Latham (ANL)
  • Rob Ross (ANL)
  • Saba Sehrish (FNAL)
  • Shane Snyder (ANL)
  • John Wu (LBL)
Statement of the Challenge

• Next-generation HEP experiments will have an order of magnitude increase in data rates and will face increasing data complexity and data volume.
  • New capabilities and methods for data processing, simulations, and data management are needed.
• ASCR HPC resources are expected to be key in addressing several of these issues.
• HEP software and workflows need to be developed to efficiently use these resources.
Goals of IOS

- The project is concentrating effort on:
  - Efficient serialization/de-serialization of data representations under parallel I/O models
    - both single node and multi-node access patterns
  - Development of persistable data representations that can be tuned for access on HPC storage systems and optimized for HEP I/O patterns.
    - may involve accelerator technologies
    - can benefit from Write-Once/Read-Many access models
  - Optimization of reads of partial, partitioned or sub-event data blocks from storage which are matched to specific algorithm consumption requirement
  - Optimization of runtime memory mapping of data to exploit batched, vectorized, and data parallel operations and transforms on columnar data.
Year 1 Plans and Accomplishments

• **1st quarter**: Document I/O patterns and event data models (EDMs)
  • Short presentations on background topics with Q&A

• **2nd quarter**: Performance of HEP experiment benchmarks on Grid resources
  • ROOT: Optimizable for HPC, xCache, Instrument ROOT I/O patterns.
  • ATLAS: EventService Simulation (fined-grained (event-wise) processing).

• **3rd quarter**: Produce benchmarks either by packaging experiments workflows or by building synthetic benchmarks

• **4th quarter**: Decide on optimization targets for memory infrastructures for phase 2.
  • For example explicit synchronous/asynchronous CPU-GPU data transfers vs unified GPU/CPU memory architectures
Ongoing Activities: Three Deeper Dives

- **Darshan for ROOT I/O in HEP workflows on HPC**
  - ROOT I/O is central to all HEP experiments. Measurements of its performance on HPC using tools like Darshan, could give valuable insights for possible improvements.
  - Shane Snyder presenting.

- **Investigate HDF5 as intermediate event storage for HPC processing**
  - In some workflows, such as the ATLAS EventService, temporary data is written to ROOT files. Moving this data to a parallel file format such as HDF5 could be beneficial.
  - Saba Sehrish presenting.

- **Testing framework for understanding scalability and performance of HEP output methods**
  - An ability to simulate HEP output of specific data products (e.g., RECO, AOD, miniAOD) in different scenarios prepares us for deeper analysis of intermediate data storage options.
  - Chris Jones presenting.