Runtime Support for Dynamic Online Data Management and Insight Discovery in Large Scale Coupled Simulation Workflow

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Research Objectives and Methodology

Objective: Use a scalable multi-tiered staging framework with internal cross-layer adaptation mechanisms to respond at runtime to dynamic data management requirements at extreme scale

Key ideas:
- Multi-tiered staging abstract & framework using deep memory hierarchy, e.g. SSD.
- Support in-situ and/or in-transit online data processing
- Cross-layer adaptation mechanisms including:
  - Adaptive spatial-temporal data resolution
  - Adaptive in-situ/in-transit placement and scheduling
  - Adaptive allocation of in-transit resources

Fig.4: Runtime framework of multi-tiered staging method in coupled simulation workflows, utilizing both DRAM and SSD.

Fig.5: A conceptual architecture for realizing runtime adaptations for in-situ/in-transit implementations of coupled simulation workflows.

Preliminary Experimental Results

Experiment platforms
ORNL Titan Cray XK7 cluster, Sith Infiniband cluster

Experiment results

Future Work

- Expanding staging area by adding an intermediate storage layer using NVRAM
- Explore impact of our approach in term of energy consumption
- Design and implement programming interface for easy usage

Fig.7: Adaptive placement and scheduling. Compared with in-situ and in-transit placements, end-to-end overhead is decreased by: 50.00%, 50.31%, 50.59%, 56.30% and 75.42%, 38.78%, 21.29%, and 49.22%.

Fig.8: Adaptive placement and scheduling. Compared with adaptive placement, data movement is reduced by: 50.00%, 48.00%, 47.90%, 39.04%.

Fig.9: Comparison of timing breakdown of the cumulative data reading time in XGC1-XGCa coupling application. More than 20% performance improvement than traditional BP file-based staging approach.

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