Application-Level Data Services

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Staging Meeting

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Application-Level Data Services

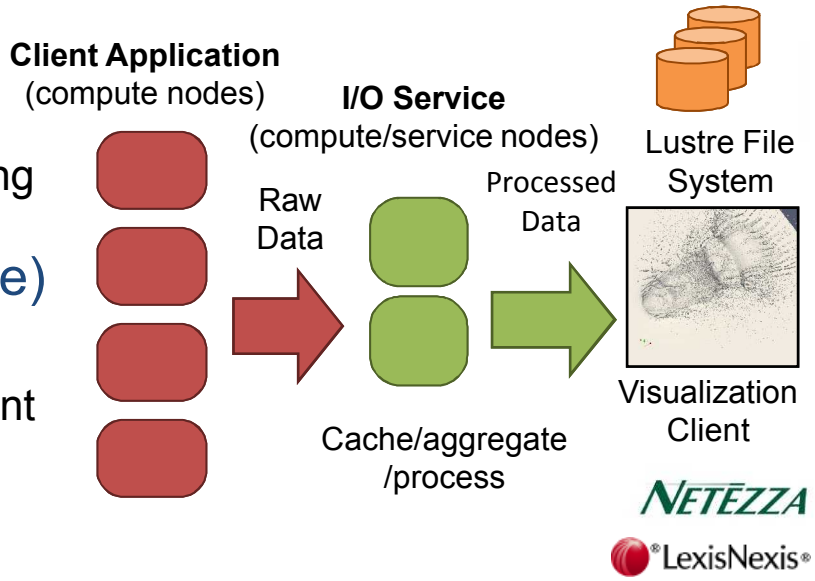
Our I/O Research is About Reducing I/O

Application-Level Data Services

- Leverage available compute/service node resources for I/O caching and data processing

Network Scalable Service Interface (Nessie)

- Developed for the Lightweight FS Project
- Framework for HPC client/server development
- Designed for scalable data movement
- Asynchronous RPC-like API



Examples

- Preprocessing for seismic imaging
- netCDF caching service
- SQL Proxy for HPC/Database Integration
- CTH Particle tracking
- Sparse-matrix viz, real-time network analysis

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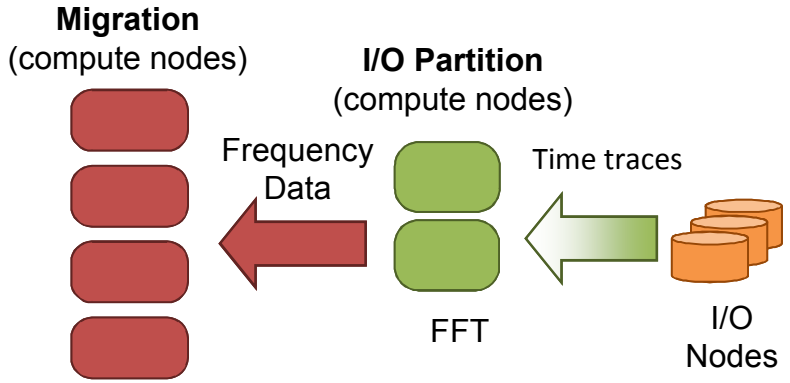
Application-Level Data Services

We did this for Salvo Seismic Imaging (circa 1996)

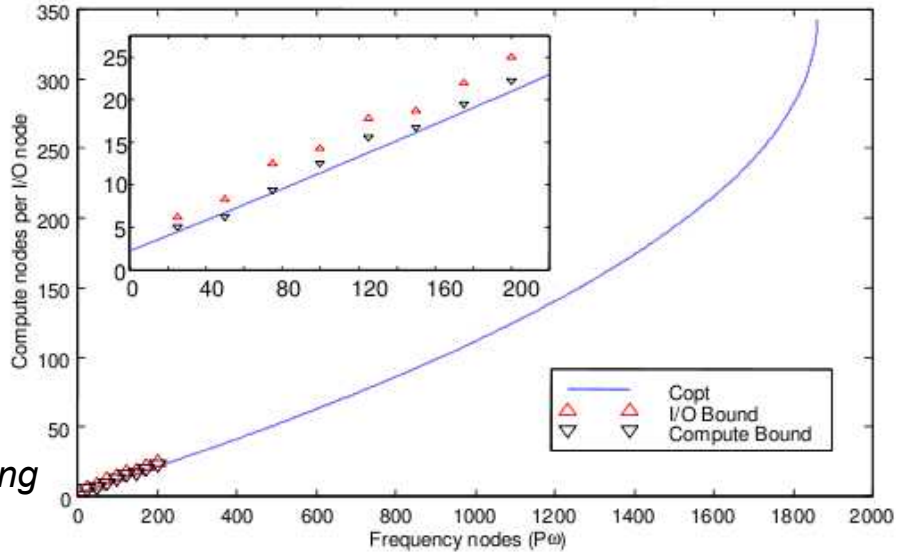
Salvo's I/O Partition

- Partition of application processors (used separate MPI Communicator for I/O)
- Used for FFT, I/O cache, and interpolation
- Async I/O allowed overlap of I/O and computation (pre-process next step)



Results

- +10% nodes led to +30% in performance
- Modeling I/O and compute costs helped find the right balance of compute and I/O nodes



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Oldfield, et al. Efficient parallel I/O in seismic imaging. *The International Journal of High Performance Computing Applications*, 12(3), Fall 1998

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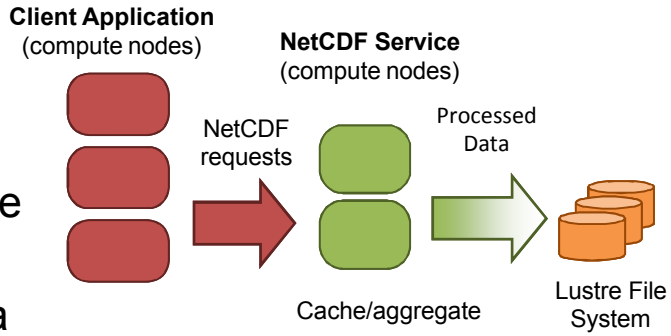
Application-Level Data Services

NetCDF I/O Cache

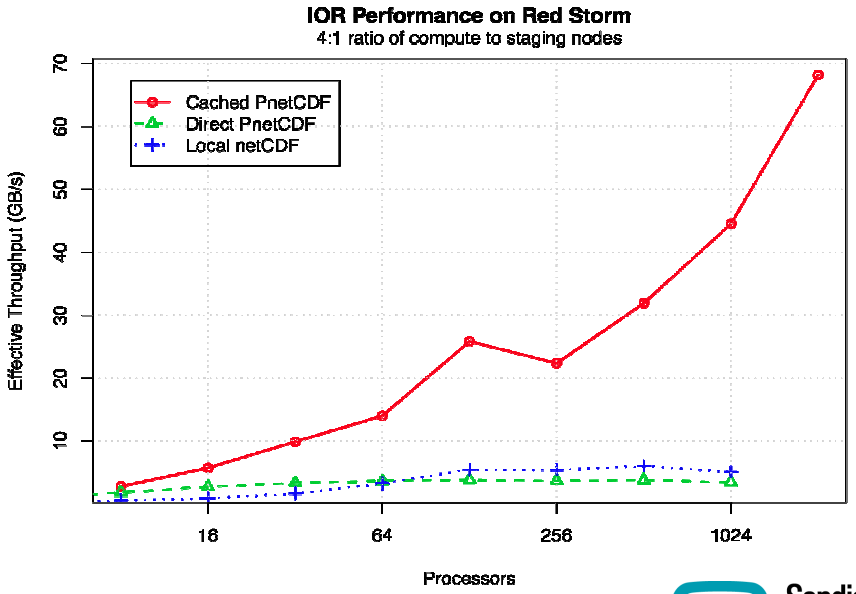
Motivation

- Synchronous I/O libraries require app to wait until data is on storage device
- Not enough cache on compute nodes to handle "**I/O bursts**"
- NetCDF is basis of important I/O libs at Sandia (Exodus)



NetCDF Caching Service

- Service aggregates/caches data and pushes data to storage
- Async I/O allows overlap of I/O and computation



Application-Level Data Services

CTH Fragment Detection

Motivation

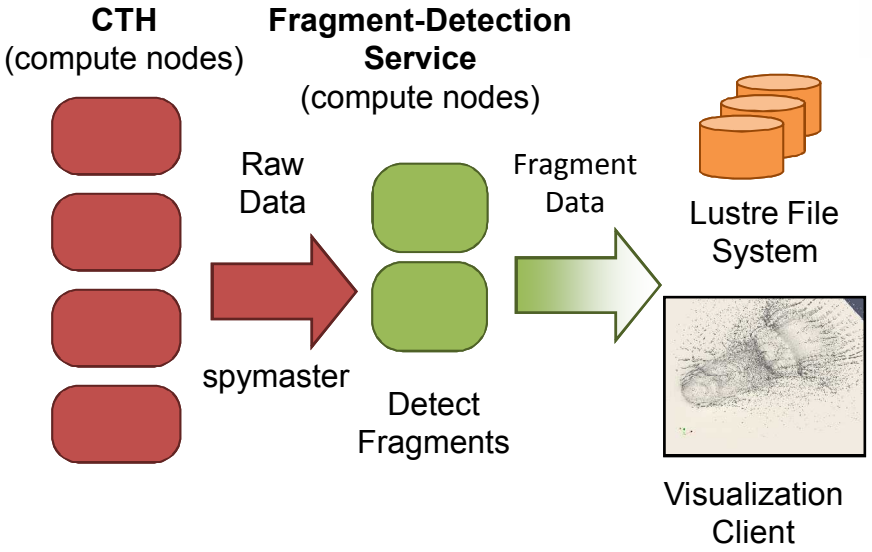
- Fragment detection requires data from every time step (I/O intensive)
- Detection process takes 30% of time-step calculation (scaling issues)
- Integrating detection software with CTH is intrusive on developer

CTH fragment detection service

- Extra compute nodes provide in-line processing (overlap fragment detection with time step calculation)
- Only output fragments to storage (reduce I/O)
- Non-intrusive
  - Looks like normal I/O (spymaster interface)
  - Can be configured out-of-band

Status

- Developing client/server stubs for spymaster
- Developing Paraview proxy service

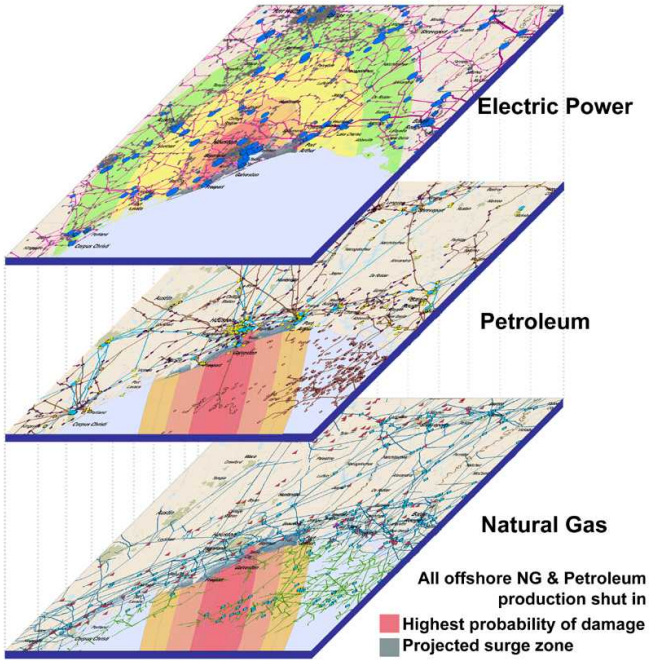


Fragment detection service provides on-the-fly data analysis with no modifications to CTH.

Application-Level Data Services

A Database Service for NISAC/N-ABLE

- Model economic impact of disruptions in infrastructure
  - Changes in U.S. Border Security technologies
  - Terrorist acts on commodity futures markets
  - Transportation disruptions on regional agriculture and food supply chains
  - Optimized military supply chains
  - Electric power and rail transportation disruptions on chemical supply chains
- Compute and data challenges
  - Models economy to the level of the individual firm
  - Model transactions from 10s of millions of companies
  - Simulation data ingested into DB for analysis
  - DB ingest is bottleneck (10x time to simulate data)
  - Time to solution is critical… want answers in hours



NISAC identifies potential consequences of disruptions to infrastructures and analyzes cascading impacts due to interdependencies

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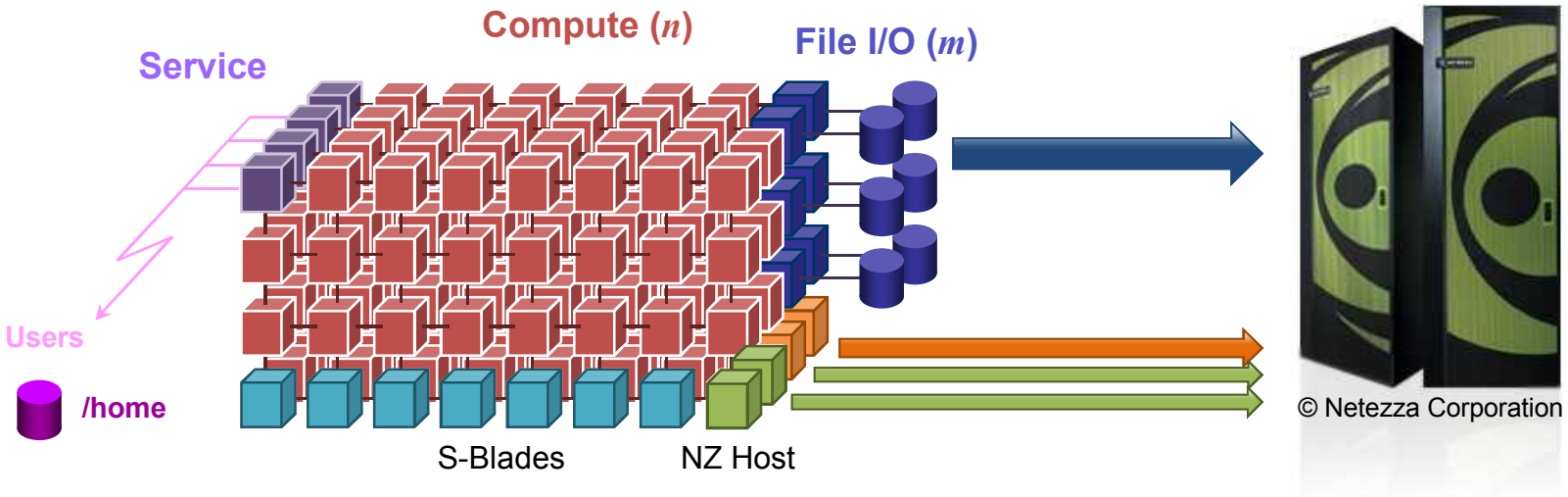
Hybrid Architecture Evolution for Database Services



Research Questions (yet to be answered)

- What ingest rates will keep up with scientific workloads?
- Where are bottlenecks? Between host and S-BLADE?
- What software/networking infrastructure will resolve the bottlenecks?

An evolving architecture to support rapid ingest for HPC workloads

1) Stage data to FS during sim, bulk load to DB after. (post-processing)
2) SQL Server sends ODBC requests to remote Netezza (slow network to host)
3) SQL Server becomes host (fast access to host, slow to S-BLADEs)
4) Multiple service-node hosts (parallel access to back-end S-BLADEs)
5) Really wacky! Hosts and S-BLADEs on fast network (fully integrated)

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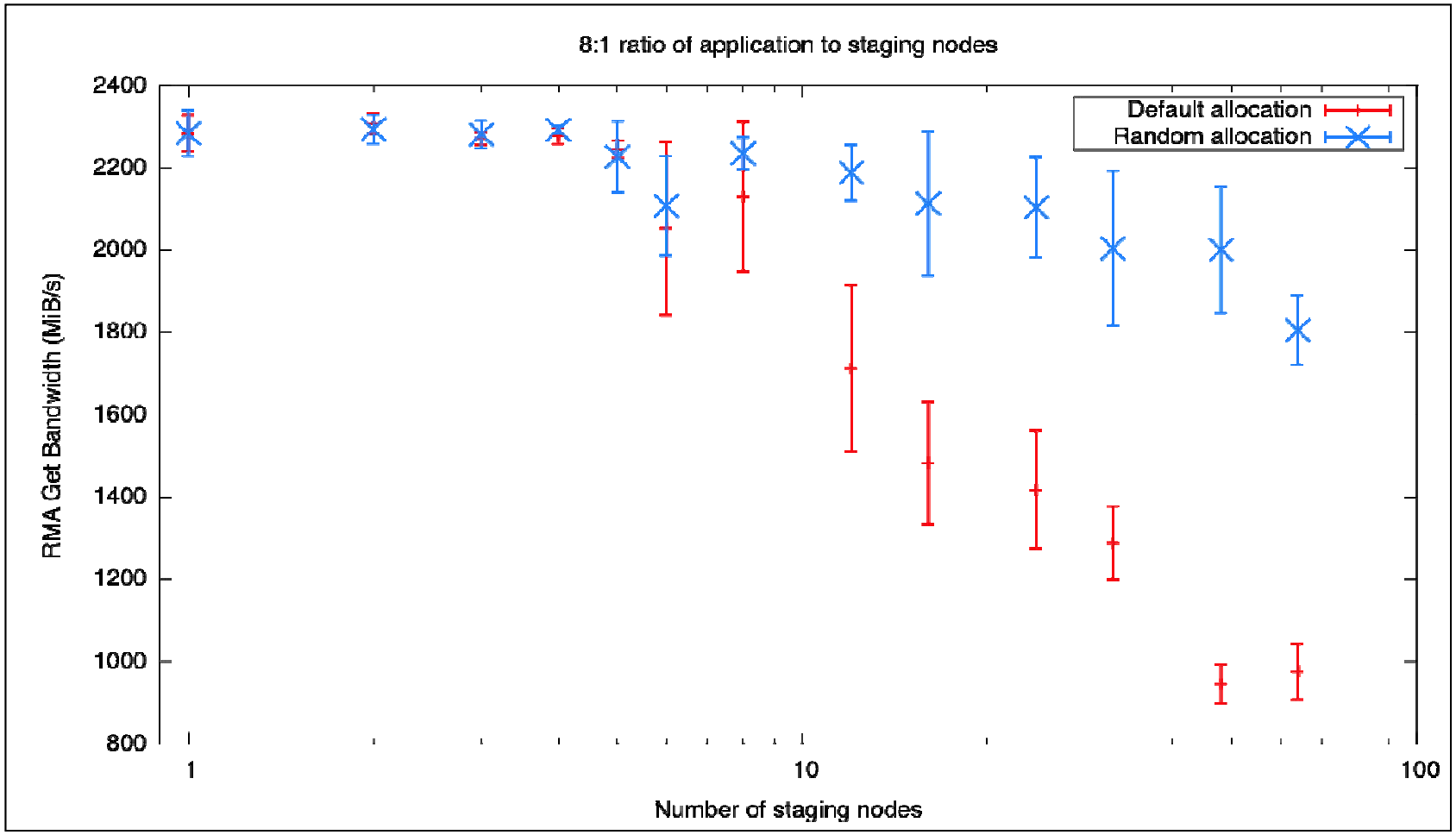
How Can System Software Help?



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