



Extending Scalability of Collective IO Through Nessie and Staging

Parallel Data Storage Workshop

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Motivation

- **Collective & Two-Phase IO proven beneficial**
 - Relatively modest data volumes, 1-D, 2-D
- **But....**
- **Trade-off of inter-node communication for data reorganization to save IO not always beneficial**
 - Large datasets
 - 3-D domain decompositions particularly bad



Motivation

- **Problem: technique is central to some IO APIs**
 - netCDF4, HDF5
- **Problem: Changing IO techniques/file format may not be an option for some applications**
 - CESM climate model is committed to netCDF file format
- **Problem: Continued scaling of problem sizes and resolution making things worse**



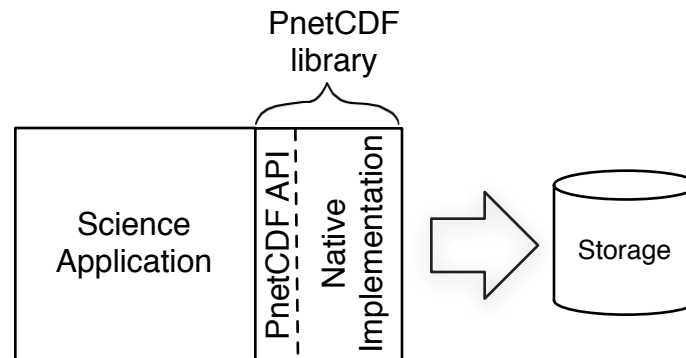
Solution

- **Use efficient transport layer and data staging transparently in the IO stack**
 - Re-implement native IO API (link-time compatible)
 - Ensure format on disk is identical
- **Requirements**
 - Efficient, portable transport layer
 - Staging area functionality to reduce time to completion

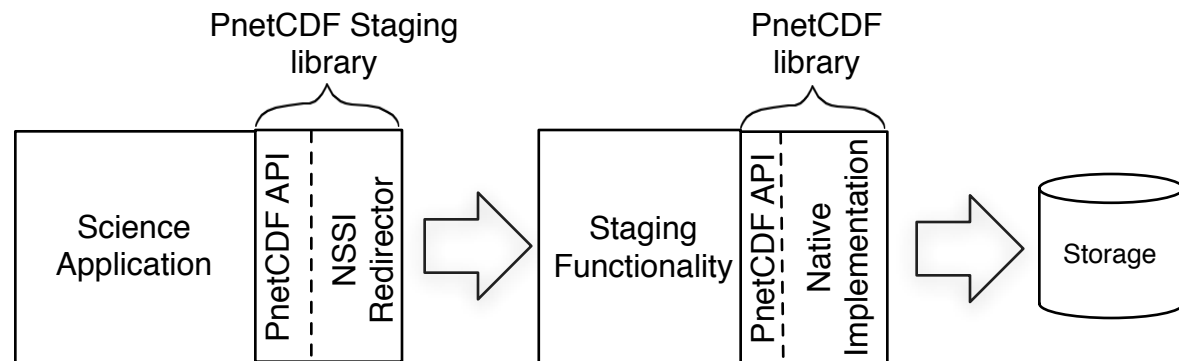


Solution Architecture

Native



Nessie





Nessie Transport Layer

- **Network Scalable Services Interface (Nessie)**
 - Originally developed for the Lightweight File Systems project
 - RPC-like asynchronous API layer supporting RDMA
 - Physical layer support
 - InfiniBand
 - Portals
 - Cray Gemini
 - Server-directed for bulk data
 - Writes: pull from client
 - Reads: push to client



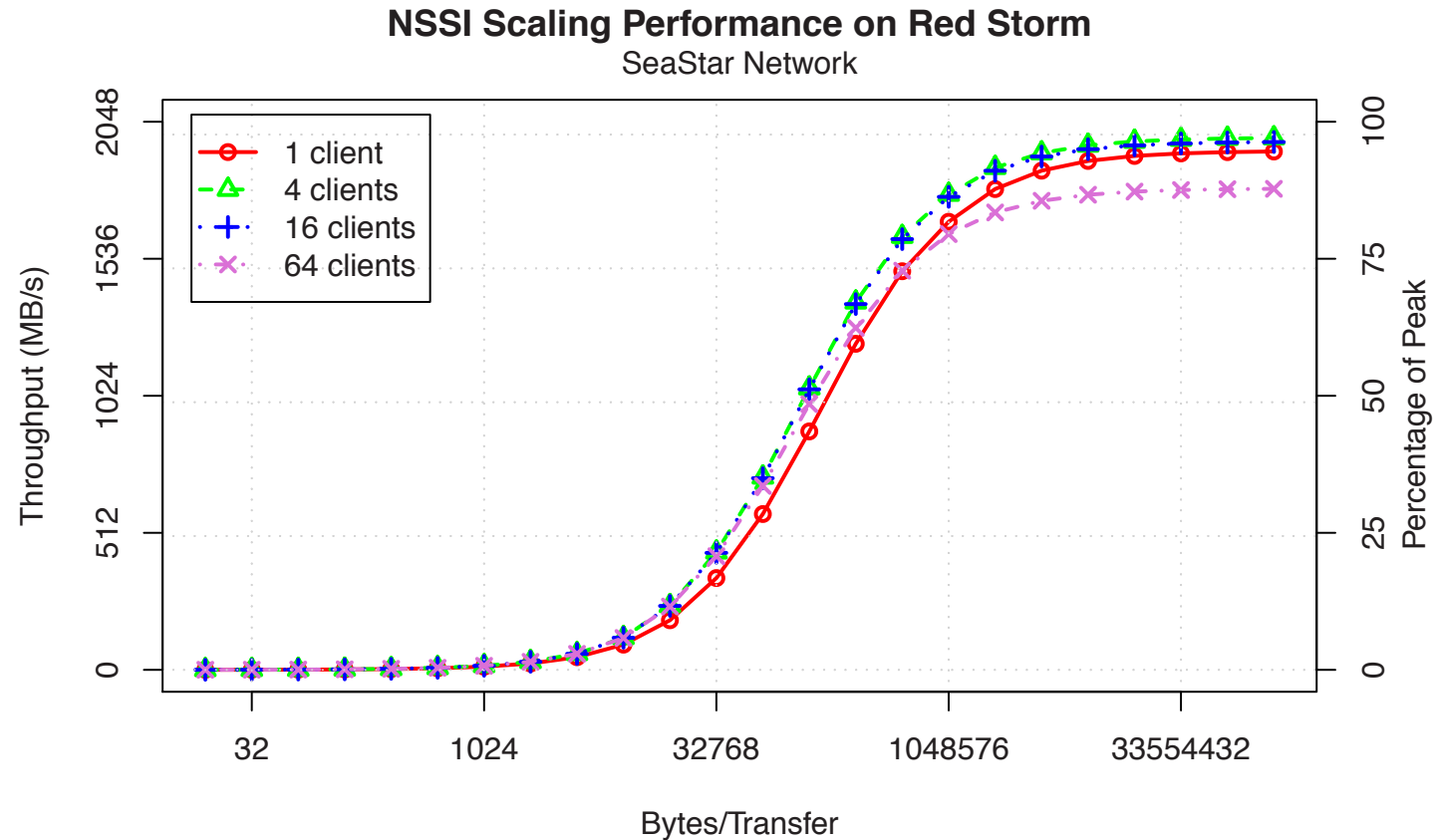


Staging Functionality

- **Collect data packets prior to writing to storage**
 - Cache data chunks to afford other optimizations
- **Perform data rearrangement**
 - Perform partial data rearrangement like two-phase IO
- **Use different techniques for writing to storage**
 - Direct, Caching, Aggregation



Nessie Performance (Portals)

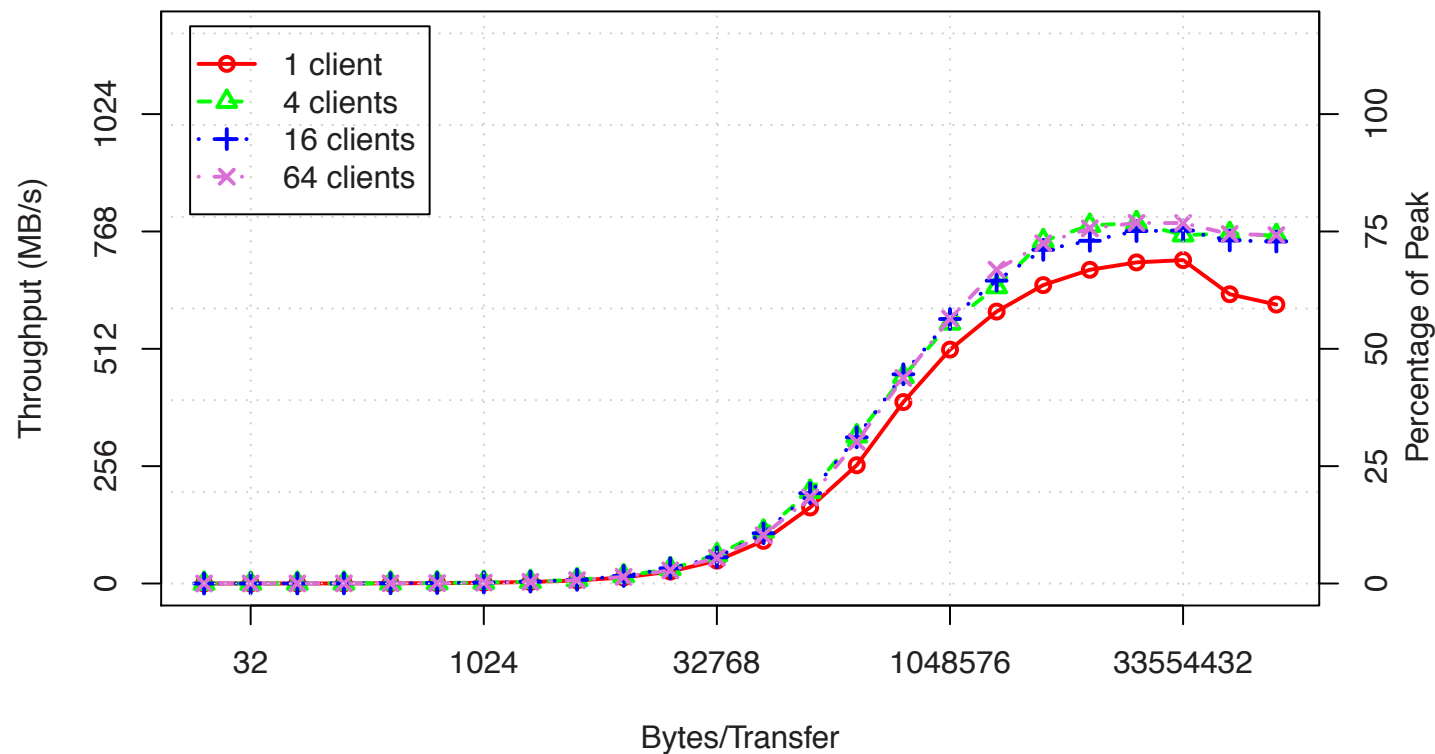


Performance of xfer_write_rdma on Red Storm



Nessie Performance (InfiniBand)

NSSI Scaling Performance on Thunderbird
InfiniBand Network

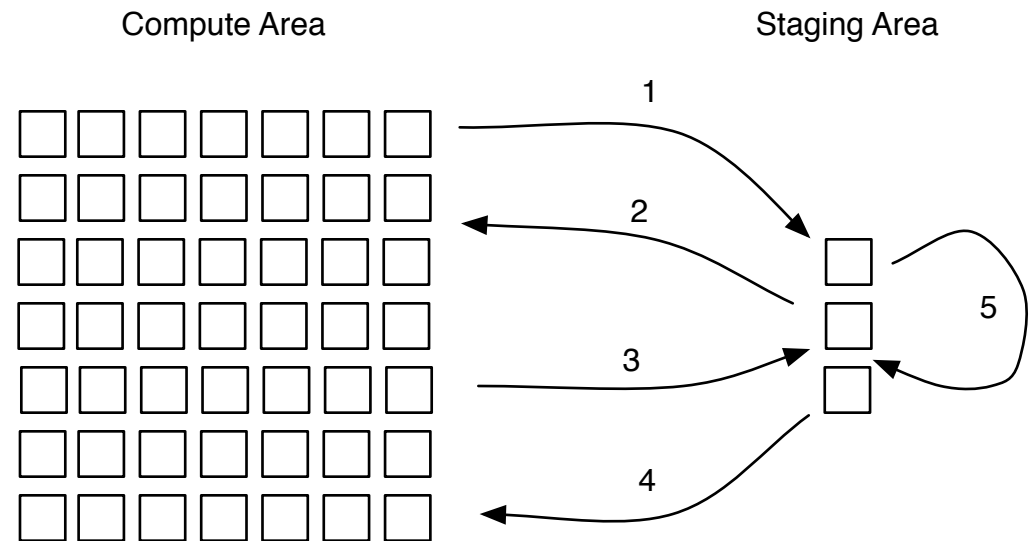


Performance of xfer_write_rdma on Thunderbird



NetCDF Staging Operation

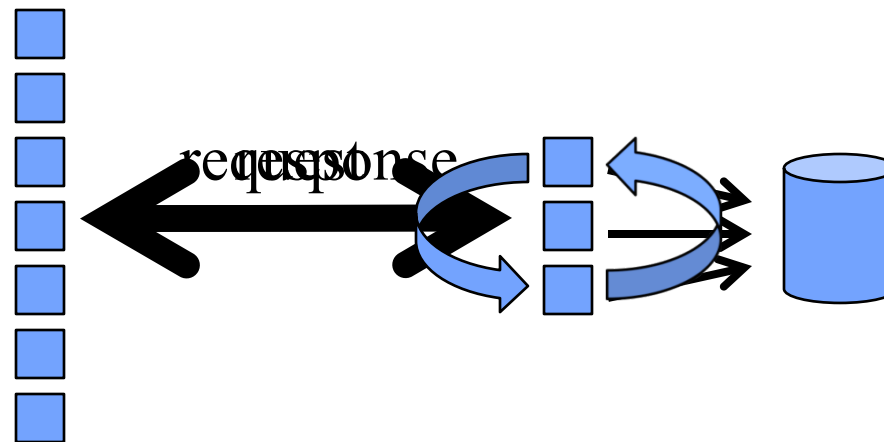
1. Initiate Request
2. Start data retrieval
3. Move data
4. Put completion/
result
5. Process in staging
area





NetCDF Staging Functionality

- NetCDF4 and PnetCDF API supported
- Direct – synchronous with client calls
- Cache Independent – asynch with client calls
- Aggregate Independent – asynch with client calls, but aggregate data prior to writing (on node only)



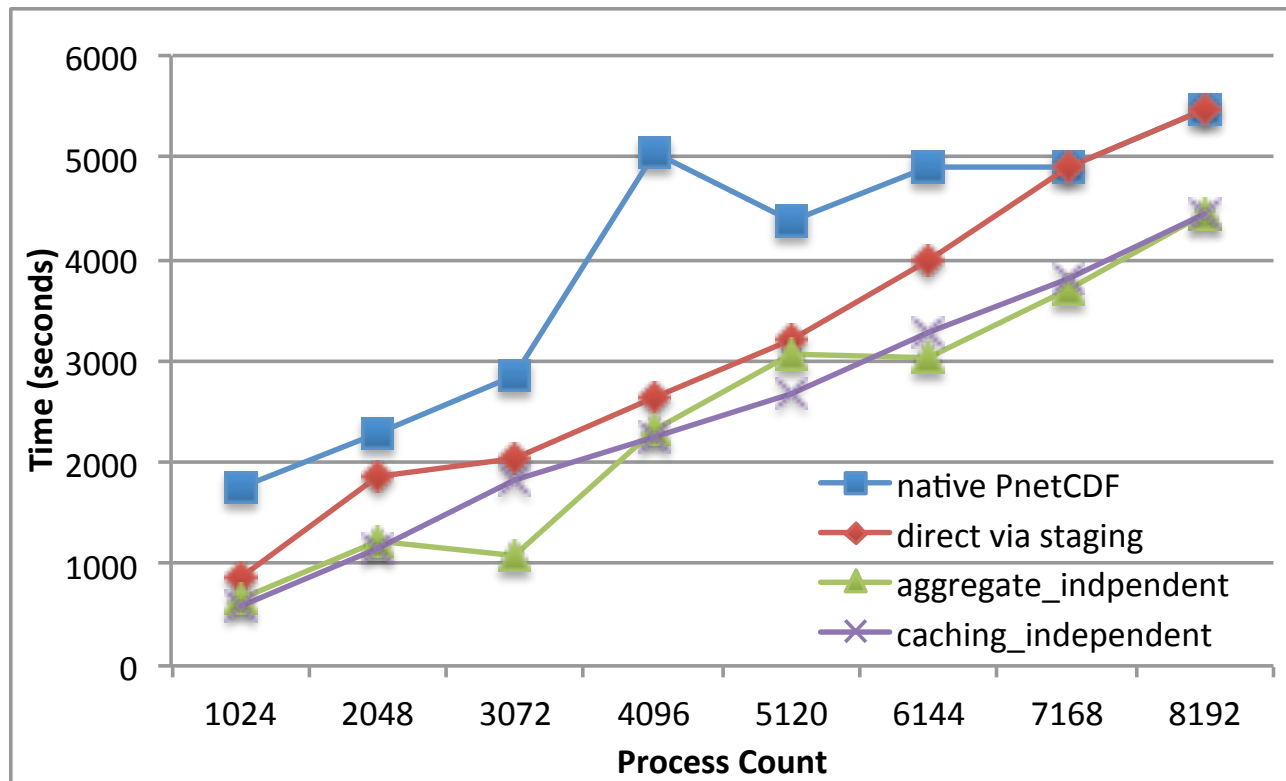


NetCDF Staging Functionality

- **Untested functionality for this paper**
 - **Collective IO versions of cache and aggregate – like independent versions, but a maximal number of collective IO calls made for writing**
 - **Other data manipulation**
 - **Different implementation using Nessie for data analysis hosting**



NetCDF Staging Performance



Testing on JaguarPF using S3D IO kernel



Current Status

- **Nessie and NetCDF staging now part of Trilinos**
 - Trios capability area
- **Port to BlueGene underway**
- **Integration of accelerators for staging processing**



Future Work

- **Finish tests on RedSky to isolate Lustre issues**
- **Test collective IO routines**
- **Examine impact on reading performance**

- **For Nessie, other applications**
 - **‘In flight’ data analysis routines**
 - **Transactions for resilience in data staging (see our poster!)**
 - **Hybrid, high level IO routine complications**
 - **Exodus + NetCDF**