Lecture 20: Parallel I/O
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Summary of last lecture

- Task mapping can be used to optimize the placement of MPI processes within a job allocation
- Can reduce inter-node communication volume and optimize it
- Heuristic-based approaches
- Metrics: hop-count, hop-bytes
When do parallel programs perform I/O?

- Reading input datasets
- Writing numerical output
- Writing checkpoints
Non-parallel I/O

- Designated process does I/O
- All processes send data to/receive data from that one process
- Not scalable
Parallel filesystem

MDS = Metadata Server
MDT = Metadata Target
OSS = Object Storage Server
OST = Object Storage Target

OST 1
OST 2
OST m
Links between cluster and filesystem

Each SU (1 management node, 1 login node, 2 LNET router nodes, 2 gateway nodes)

- Compute node
- LNET router node
- Object storage server (OSS)
Different parallel filesystems

- Lustre: open-source (lustre.org)
- GPFS: General Parallel File System from IBM, now called Spectrum Scale
- PVFS: Parallel Virtual File System
Tape drive (archive) and burst buffers

- Store copy of data on magnetic tapes for archival

- Burst buffers: fast, intermediate storage between compute nodes and the parallel filesystem

- Two designs:
  - Node-local burst buffer
  - Remote (shared) burst buffer
I/O libraries

- High-level libraries: HDF5, NetCDF
- Middleware: MPI-IO
- Low-level: POSIX IO
Different I/O patterns

- One process reading/writing all the data
- Multiple processes reading/writing data from/to shared file
- Multiple processes reading/writing data from/to different files
- Different performance depending upon number of readers/writers, file sizes, filesystem etc.