Data Storage and Data Analysis Workflows for Research

November 10, 2015

The Minnesota Supercomputing Institute for Advanced Computational Research
Tutorial Outline

- Hardware overview
- Systems overview
- Options at UMN
- Options at MSI
- Interfaces to MSI storage
  - Moving data on and off storage systems
- Performance issues
- Use Cases
- Hands on
Storage Technologies
Computer Memory Hierarchy

- CPU Registers
- Processor Cache
- Random Access Memory
- Flash or USB Memory
- Hard Drive Disks
- Tape Backup

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Ask Questions First

Not all storage is created equal

• What do I want to do with the data?
  • How large are the files I’m storing?
  • How many files will I store?
  • How frequently will I access the data?
  • From what locations will I access the data?
  • In what format will the data be stored?
Storage Technologies

Hardware

- **Hard Disk Drives (HDDs)**
  - Rotating rigid platters on a motor-driven spindle within a protective enclosure. Data is magnetically read from and written to the platter by heads that float on a film of air above the platter.

- **SATA -- Serial Advanced Technology Attachment**
  - Desktop
  - Low cost
  - up to 8 TB
  - ~ 6 Gb/s
  - ~1.6 million hours MTBF

- **SAS -- Serial Attached SCSI**
  - Enterprise use
  - Costly
  - up to 8 TB
  - ~ 12 Gb/s
  - ~1.2 million hours MTBF
Storage Technologies
Hardware

• Solid State Drives (SSDs)
  - Use microchips which retain data in non-volatile memory chips.
  - No moving parts
  - less susceptible to physical shock
  - silent
  - very low access time
  - very expensive (Compared to HDDs)
  - ~1.5 million hours

• Hybrid HDD and SSD drives (SSHD)
  - SSDs add speed to cost effective media by acting as Cache
Storage Technologies
Hardware

• RAM Disk
  • Block of random-access memory (primary storage or volatile memory) that a computer’s software is treating as if the memory were a disk drive (secondary storage).
  • Used to accelerate processing
  • No moving parts
  • Very low access time (Compared to HDDs and SDDs)
  • Very expensive (Compared to HDDs and SDDs)
  • Data lost when powered off or rebooted
Storage Technologies
Future of Storage

- Better conventional HHDs
  - Helium Filled
  - Shingled Magnetic recording (SMR)
  - Heat-assisted magnetic recording (HAMR)
- Better/Cheaper Solid State solutions?
  - Phase Change Memory (PCM)
  - Could flatten complex data hierarchies?
- DNA digital data storage for archive storage
  - Very slow but extremely dense
Storage Technologies
How do we use these devices?

Devices
- Memory
- Block
- Arrays of Disks

Filesystems
- Disk File Systems
  - Ext4, ZFS
- Network File Systems
  - NFS, SMB
- Parallel File Systems
  - Panasas, Lustre, GPFS
- Special Cases
  - FUSE
    (Filesystem in Userspace)
  - CephFS

Services
- Cloud
  - Google drive, Dropbox, Amazon (S3)
- Databases
  - MySQL, CouchDB

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## Storage Technologies

### Order of Magnitude Guide *

<table>
<thead>
<tr>
<th>Storage</th>
<th>Files/dir</th>
<th>File sizes</th>
<th>Band Width</th>
<th>IOPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local HDD</td>
<td>1,000s</td>
<td>GB</td>
<td>100 MB/s</td>
<td>100</td>
</tr>
<tr>
<td>Local SSD</td>
<td>1,000s</td>
<td>GB</td>
<td>1 GB/s</td>
<td>10,000+</td>
</tr>
<tr>
<td>RAM FS</td>
<td>10,000s</td>
<td>GB</td>
<td>10 GB/s</td>
<td>10,000</td>
</tr>
<tr>
<td>NFS</td>
<td>100s</td>
<td>GB</td>
<td>100 MB/s</td>
<td>100</td>
</tr>
<tr>
<td>Lustre/GPFS</td>
<td>100s</td>
<td>TB</td>
<td>100 GB/s</td>
<td>1,000</td>
</tr>
<tr>
<td>Cloud</td>
<td>Infinite</td>
<td>TB</td>
<td>10 GB/s</td>
<td>0</td>
</tr>
<tr>
<td>DB</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1,000</td>
</tr>
</tbody>
</table>

*From SDSC 2015 Summer institute: HPC and Long Tail of Science*
Storage Technologies
Data Redundancy

• Mirroring
  • Create identical copies of Files

• RAID (Redundant Array of Independent Disks)
  • Multiple disks pooled into a single logical unit
  • RAID with N=2 is Mirroring
  • Larger disk pools (N>2) can save storage
  • Uses a parity to recreate missing data when drive is lost

• Snapshot
  • Creates a copy of the current state of the system to disk
  • Very fast, doesn’t delay subsequent writes.

• Tape backup
  • Refers to the media, portable
  • Typically less expense
  • Offline for Disaster recovery purposes.
Storage Technologies
A Cautionary Tale

http://www.youtube.com/watch?v=gDfLXAtRJfY&feature=youtu.be
Storage Options at UMN

- **Department**
  - Workstation
  - Departmental Servers

- **OIT**
  - Google Drive
  - Isilon
  - Block Storage

- **MSI**
  - Panasas
  - Tier-2 CEPH

- **Library**
  - DRUM, Data Repository for the U of M

- **You**
  - Laptop
  - Mobile
## Storage Options at UMN

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Google Drive</th>
<th>OIT Isilon</th>
<th>OIT Block</th>
<th>MSI Panasas</th>
<th>MSI Tier-2</th>
<th>Dept Storage</th>
<th>Laptop/Desktop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Data</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>High Performance</td>
<td></td>
<td>✔️</td>
<td></td>
<td></td>
<td>☐</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share access</td>
<td>✔️</td>
<td></td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td>✔️</td>
</tr>
<tr>
<td>Archival (very long-term) storage</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td>✔️?</td>
<td>✔️?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access on Campus Laptop/Desktop</td>
<td>✔️</td>
<td></td>
<td>✔️?</td>
<td>✔️?</td>
<td>✔️?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access on anywhere Laptop/Desktop/Mobile</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️?</td>
<td>✔️?</td>
<td>✔️?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access on Servers</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️?</td>
<td>✔️?</td>
<td></td>
<td>✔️</td>
</tr>
<tr>
<td>Legally protected data (Coming)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

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So Many Choices, So Much Data

Sometimes it’s best to come with good questions rather than a single solution:

http://www.youtube.com/watch?v=F4OIDszDA9E!
Gopher Science Network at UMN

UMN Network with Proposed Gopher Science Network (GSN)

Campus centers are currently severely constrained by 1 GbE connectivity.

St. Paul Campus
OpenCDN Group (Keller Hall)
MPC
UMGC CMRR

Synder Hall
CMSP

100 GbE to POP (internet 2)

MSI Core

Mesabi
Itasca
Panasas
Big Data Ceph

MSI provides a variety of research platforms for researchers and manages an internal 10/40/100 GbE network.

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Storage at MSI
Store and Stage Data

What’s available at MSI:

- Shared file system: PanFS
- 2nd Tier Storage: CEPH
- Databases: Web servers
- Local Disk
- RAM disk
Shared File system

**What it is**

PanFS: Block storage; POSIX
Visible on all MSI systems
Persistence: duration of your account at MSI

**How you access it:**

Directories: home, shared, public, scratch
Shell commands: cp, mv, rm, grep, ...
Applications: all POSIX file IO
Shared File system

Locations & Uses

/home/<group>/<user>  Your private files
/home/<group>/shared   Share with your group
/home/<group>/public   shared with all MSI
/scratch.global       Temp. files for multiple hosts

Limits

/home/<group>/*    group quota  (allocation)
/scratch.global  1 month lifetime & SLOW!
2nd Tier Storage

What it is

CEPH: Object storage; S3
Visible on all MSI systems and Web
Persistence: duration of allocation

How you access it:

By file only
Files organized in “buckets”
Shell: s3cmd
Web URL

https://www.msi.umn.edu/content/second-tier-storage
CEPH: S3 interface

Locations & Uses

s3://<bucket name>/<file name>
s3cmd commands: ls; get; put
Save & stage large volumes of data

Limits

CEPH write access by group allocation
CEPH read access can be granted by user
Databases & Web Services

**What it is**

Database services & servers managed by MSI
Visible on hosts with web access
Persistence: lifetime of project

**How you access it:**

Web URL
Shell: wget or database clients
Get access through a coordinated MSI project
Databases

Locations & uses

URL: www.msi.<name>

Share data with a community
Informatics applications

Limits

Capacity & bandwidth specific to project
Local Disk

What it is
Non-RAIDed Disk or SSD: POSIX
Visible on host system only
Persistence: duration of PBS job

How you access it:
Shell commands: cp, mv, ...
Applications: all POSIX file IO
Local Disk

**Locations & Uses**

/scratch.local

[/<user>/<path>]/<file name>

Scales well to many hosts writing to their own files

⇒ Good place for your scratch/work directory

**Limits**

Scope: local host and life of PBS job

relatively poor bandwidth, except for fragmented IO

Typical capacity: 420 GB
RAM Disk

**What it is**
- Local system memory
- Visible only on local host
- Persistence: duration of PBS job

**How you access it:**
- Shell commands: cp, mv, ...
- Applications: all POSIX file IO
RAM Disk

**Locations & uses**
/dev/shm

[path]/<file name>

Scalable to many hosts reading their own files
High bandwidth and low latency
Efficient fragmented IO

**Limits**
About ½ system memory (32 GB on a Mesabi node)
Scope: local to node and only during PBS job.
## Data Hierarchy: Mesabi Compute Node

<table>
<thead>
<tr>
<th></th>
<th>Capacity</th>
<th>Latency</th>
<th>Bandwidth</th>
<th>Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cache</td>
<td>60 MB</td>
<td>~ 10 ns</td>
<td>~ 3 TB/s</td>
<td>In Process</td>
</tr>
<tr>
<td>Memory</td>
<td>64 GB - 1 TB</td>
<td>~ 100 ns</td>
<td>~ 30 GB/s</td>
<td>In Process</td>
</tr>
<tr>
<td>RAM Disk</td>
<td>32 GB - 512 GB</td>
<td>~ 0.1 ms</td>
<td>~ 400 MB/s * N</td>
<td>POSIX IO</td>
</tr>
<tr>
<td>SSD</td>
<td>440 GB</td>
<td>~ 0.26 ms</td>
<td>~ 400 MB/s</td>
<td>POSIX IO</td>
</tr>
<tr>
<td>Local Disk</td>
<td>420 GB</td>
<td>~ 24 ms</td>
<td>~ 100 MB/s</td>
<td>POSIX IO</td>
</tr>
<tr>
<td>PanFS</td>
<td>2.5 PB</td>
<td>~ 2 ms</td>
<td>0.4 - 25 GB/s</td>
<td>POSIX IO</td>
</tr>
<tr>
<td>CEPH</td>
<td>2.1 PB</td>
<td>~ 1 sec</td>
<td>60 - 200 MB/s</td>
<td>By File (S3)</td>
</tr>
<tr>
<td>WAN</td>
<td>→ Infinity</td>
<td>~ 1 sec</td>
<td>1 - 60 MB/s</td>
<td>By Web service</td>
</tr>
</tbody>
</table>

- Cache to register bandwidth based on HPL efficiency
- I’ve measured memory BW at 28 GB/s; cache: 267 GB/s
- Latencies and bandwidths are as measured in real apps.
Interfaces
(Getting Started)
Move data to and from MSI

**Applications, utilities, & services**

- **scp**: can push to msi from external host
- **wget**: Pull from within MSI only
- **Git**: Pull or push from within MSI only
- **s3cmd**: Push data to and pull data from CEPH
- **Globus**: Web based control from anywhere

**Access for incoming traffic**

- Must be within UofM domain (use UofM VPN)
- Must go through MSI front end server
- `login msi umn.edu`
Secure Copy (scp)

- Login to MSI host
- Copy files & directories between a remote server and MSI

**Login to MSI**

```bash
ssh <msi_user>@login.msi.umn.edu
```

**Copy to MSI**

```bash
scp  <rhost_user>@<rhost>:<path>/<file>   <path>
scp -r <rhost_user>@<rhost>:<path>             <path>
```

**Copy from MSI**

```bash
scp <file>  <rhost_user>@<rhost>:<path>
scp -r <path>  <rhost_user>@<rhost>:<path>
```
Get Files from web (wget)

- Run client (wget) from MSI host
- Get files, source code, data posted on web
  Files must be posted on a server that support wget
  You must have the URL

**On an MSI host: get a file from the web:**

`wget <URL>`
Repositories (git)

- Sharing data & source with others: Version control
- Can run git locally or with a github
- UofM github: https://github.umn.edu
- Documentation: https://training.github.com

**On MSI host: command prompt**

- get add
- git commit
- git merge
CEPH (s3cmd)

**What is it good for?**

- Move large volumes of data to and from CEPH
- Stage and share data for processing
- High bandwidth: up to 250 MB/s

**From MSI Linux shell (command prompt)**

```
s3cmd mb s3://<bucket>
s3cmd put <file>  s3://<bucket>
s3cmd get s3://<bucket>/<file>  <directory>
s3cmd ls s3://<bucket>
```

Globus

What is it good for?

- Move data between sites across WAN
- Web GUI driven
- Move LARGE directory trees with drag and drop
- Runs in background

How to use

- Get Globus account:
- Register your certificate ID with Globus endpoints
- Use web GUI to drag and drop between endpoints

www.globus.org
Sign Up: register here

Enter:
Name
Email
Username
Password
Organization
Options

Only need to do this once

Will get simpler.

Sign Up

Full Name

Email

Username
Your username can only contain lower case letters and must begin with one. It may contain numbers.

Password
Better passwords are longer, use mixed case letters with punctuation and numbers.

☐ Show Password

This account will be used for
☐ non-profit research or educational purposes
☐ commercial purposes

Organization

☐ I have read and agree to the Globus Terms of Service and Privacy Policy.
☐ Please email me updates about Globus

Register
Enter

Globus

username

password

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After sign in: select activity

Select: Transfer Files
File Transfer Dialog

Enter

2 Endpoints
Source
Destination

Transfer Files

Get Globus Connect Personal
Turn your computer into an endpoint.

Endpoint enter endpoint name Go Endpoint enter endpoint name Go
Path Go Path Go

Please select an endpoint above.

more options Label This Transfer

This will be displayed in your transfer activity.
Enter Endpoint for MSI

 MSI:

msihpc#panfs

msihpc#panfs
Authenticate To MSI Endpoint

"Globus" requests that you select an Identity Provider and click "Log On". If you do not approve this request, do not proceed.

By proceeding you agree to share your name and email address with "Globus".

Select:

University of Minnesota

Site Name: Globus
Site URL: https://www.globus.org
Service URL: https://www.globus.org/service/graph/authenticate_oauth_callback

Select An Identity Provider:

University of Massachusetts Amherst
University of Miami
University of Michigan
University of Minnesota

Search: 

Remember this selection: □

Log On

By selecting "Log On", you agree to CIlogon's privacy policy.
NOTE:

This generates a certificate.

Only need to do this once every few weeks.
Connected to MSI

MSI home directory

Can grows to directory of interest.
Etnier Endpoint for Physics

Physics Endpoint

umnphys#data

Same UofM authentication
Connected to Physics Server

Endpoint in phys. connected to a 200 TB disk system

This physics endpoint is in the same domain as MSI ⇒ did not need to authenticate again.
Example: pipe directory tree

About 4 levels deep

Irregular

Hundreds of directories

Thousands of files

~0.6 GB
Brows to source and destination

**Source**
Folder: pipes
Could be a file or a directory.

**Destination**
path: /data/uchu

Supercomputing Institute for Advanced Computational Research

Driven to Discover™
File transfer Requested

Temporary notice

Confirms submission of request
### Activity

<table>
<thead>
<tr>
<th>Status</th>
<th>Transfer Details</th>
<th>Completion Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>msihpc#panfs to umnphys#data</td>
<td>transfer completed a few moments ago</td>
</tr>
<tr>
<td>✓</td>
<td>msihpc#panfs to umnphys#data</td>
<td>transfer completed 22 days ago</td>
</tr>
<tr>
<td>✓</td>
<td>msihpc#panfs to umnphys#data</td>
<td>transfer completed a month ago</td>
</tr>
<tr>
<td>⬤</td>
<td>msihpc#panfs to umnphys#data</td>
<td>transfer cancelled a month ago</td>
</tr>
</tbody>
</table>

Small transfer ~3 min
Details

Click on request to see details.

7788 files
476 folders
598 MB
~3.5 MB/s

Supercomputing Institute for Advanced Computational Research
Larger & Fewer Files

More efficient

32 files
1 folder
200 GB

Took: 38 min.

~88 MB/s
Email Confirmation

SUCCESSED - 7cbcb016-84ad-11e5-9
94f-22000b96db58

Globus Notification <no-reply@glot

11:44 AM (1 hour ago) ☆

to me

TASK DETAILS
Task ID: 7cbcb016-84ad-11e5-994f-22000b96db58
Task Type: TRANSFER
Status: SUCCEEDED
Is Paused: No
Request Time: 2015-11-06 17:40:36Z
Deadline: 2015-11-07 17:40:36Z
Completion Time: 2015-11-06 17:43:31Z
Total Tasks: 8265
Tasks Successful: 8265
Tasks Expired: 0
Tasks Canceled: 0
Tasks Failed: 0
Tasks Pending: 0
Tasks Retrying: 0
Command: API 0.10 go
Label: n/a
Source Endpoint Name: msihp#panfs
Destination Endpoint Name: umnphys#data
Source Endpoint: d62d1e8d-6d04-11e5-ba46-22000b92c6ec
Destination Endpoint: e4c16ea6-6d04-11e5-ba46-22000b92c6ec
Sync Level: n/a
Data Encryption: No

Sent when done
Includes stats
Use Cases
(HPC Workflows)
Cross OS Workflows

Use case
Complex geometry & physics
Computationally intensive solutions
Use commercial software (example: ANSYS)

The issue
ANSYS Workbench & GUIs run best on MS Windows
ANSYS solvers scale excellently on Mesabi (Linux cluster)

The solution
Setup model & view results w/ GUIs on Citrix VMs
Run solvers on Linux cluster
Use PanFS home directory as the glue
Data Intensive Workflows

**Use case:**
Need to process many large files
Need to access various subsets of data in many ways

**The issues:**
Total volume of data is too large for group quota
fragmented IO slow on shared file system
MANY users on shared file system → very slow access

**The Solution:**
Stage full data set on CEPH in many files
Stream needed files to RAM disk in PBS jobs
Process on RAM disk and save results to PanFS or CEPH
Post processing example

Have: raw data from an MHD turbulence model.
   Mesh res: 256x256x256
   Full state info: (density, velocity, B-field)
   300+ snapshots in time
   Individual snapshot size: 470 MB

Want: Power spectra of velocity field
   Post-process each time snapshot
   Can be done independently
   Calculation (including IO) takes ~16 s
Serial workflow

<table>
<thead>
<tr>
<th>command</th>
<th>status</th>
</tr>
</thead>
<tbody>
<tr>
<td>./do1spc 0000</td>
<td>FINISHED</td>
</tr>
<tr>
<td>./do1spc 0001</td>
<td>FINISHED</td>
</tr>
<tr>
<td>./do1spc 0002</td>
<td>INPROGRES</td>
</tr>
<tr>
<td>./do1spc 0003</td>
<td>NEW</td>
</tr>
<tr>
<td>./do1spc 0004</td>
<td>NEW</td>
</tr>
</tbody>
</table>

Run app. on state 0002

Raw data PanFS
Generate V-spectra
copy to output directory

e6a02-0000-000
e6a02-0001-000
e6a02-0002-000
e6a02-0003-000
e6a02-0004-000
...
e6a02-0000-V3.spc3v
e6a02-0001-V3.spc3v
e6a02-0002-V3.spc3v
e6a02-0003-V3.spc3v
e6a02-0004-V3.spc3v
Serial Throughput (0-9)

Lines show span of time each work item took

1 work item = process one time snapshot
Parallel workflow

... ./do1spc 0007  FINISHED
./do1spc 0008  FINISHED
./do1spc 0009  INPROGRESS
./do1spc 0010  INPROGRESS
./do1spc 0011  INPROGRESS
./do1spc 0012  NEW
./do1spc 0013  NEW
./do1spc 0014  NEW
...

Run app. on state 0009
Run app. on state 0010
Run app. on state 0011

... e6a02-0007-V3.spc3v
e6a02-0008-V3.spc3v
e6a02-0009-V3.spc3v
e6a02-0010-V3.spc3v
e6a02-0011-V3.spc3v
...

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Parallel throughput (0-40)

1 Mesabi node
20 Workers

Each worker grabs next work item as soon as it finishes

Variable times:
- Shared PanFS
- Variable loads
Parallel Throughput (0-299)

1 Mesabi node
20 Workers
Processed:
  300 files
  330 sec.

1 worker:
  300 files
  ~4800 sec
Process data from CEPH

**Workflow with raw data on CEPH**

Use s3cmd to pull raw data files

CEPH ⇒ RAM disk

Process on RAM disk then copy results to PanFS

**Issue**

If not staged on CEPH SSDs, getting 440MB can take ~17s

**Overlap copy from CEPH with calculation**

1 work item = process 5 consecutive states

work on state i while pulling state i+1
Parallel throughput from CEPH

1 Mesabi node
20 Workers
Processed:
  300 files
  390 sec.

Compare to same data off of PanFS:
  330 sec
Thank You
Hands-On
Project lifecycle

• Get & build an application
• Run application, generate data, examine results
• Organize and save data
• Share data
• Clean up
Get Application

Get example from web & unpack
wget www.msi.umn.edu/~porter/tut/cycles.tarz
  tar xvfz cycles.tarz

Go into directory and build example application
  cd cycles
  make
Test application

Run application to get synopsis
./cycles

Should get synopsis: usage: poly <fx> <fy>
App. takes two command line arguments.
These can be integers or floats.

Try an example
./cycles 1 2

You should get 1001 lines: 2 columns of numbers
Run a test case & plot results

**Script test1:**

```
./cycles 3 5 > cyc_3_5.dat
gnuplot -persist cyc_3_5.plt
```

**Run it:**

```
./test1
```
Try your own Parameters

Script test2
   ./cycles $1 $2 > cycles.dat
gnuplot -persist cycles.plt

Try several examples
   ./test2 2 3
   ./test2 13 25
   ./test2 2 3.02
Parameter space study

Script test3

```
#!/bin/bash
for j in $(seq 1 2 7)
do
for i in $(seq 2 2 8)
do
   ./cycles $i $j > cyc_${i}_${j}.dat
done
done
done
ls -l cyc*.dat
```

Run it and generate output files (cyc*.dat)

./test3
Organize & your data

**Make an output directory**

```
mkdir output
mv *.dat output
```

**Make a zipped tar file**

```
tar cvfz output.tarz output
```

**Share with other members of your group**

```
cp -r output ~/../shared
chmod -R g=u-w ~/../shared/output
```
Save data to CEPH

**Make a bucket and save a file**

module load s3cmd
s3cmd mb s3://mytest
s3cmd put output/cyc_2_1.dat s3://mytest

**Save all data file to bucket**

for i in output/*
    s3cmd put $i s3://mytest
done

**or save tar archive**

s3cmd put output.tarz s3://mytest

Which is faster?
Use data on CEPH

Get a data file to/from bucket

s3cmd get s3://mytest/cyc_2_3.dat .

Desktop & Web access to CEPH

https://www.msi.umn.edu/support/faq/what-are-some-user-friendly-ways-use-second-tier-storage-s3
Clean up

The situation
Immediate analysis is done.
Data is organized, saved shared and saved (on CEPH)
Assume the data is a large fraction of your group quota

Time to clean up
Fine to save source, scripts, and inputs in you home directory
Better to have them organized where you and your group can find it
⇒ Remove the large data files