DataWarp Transparent Cache: Implementation, Challenges, and Early Experience

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Agenda

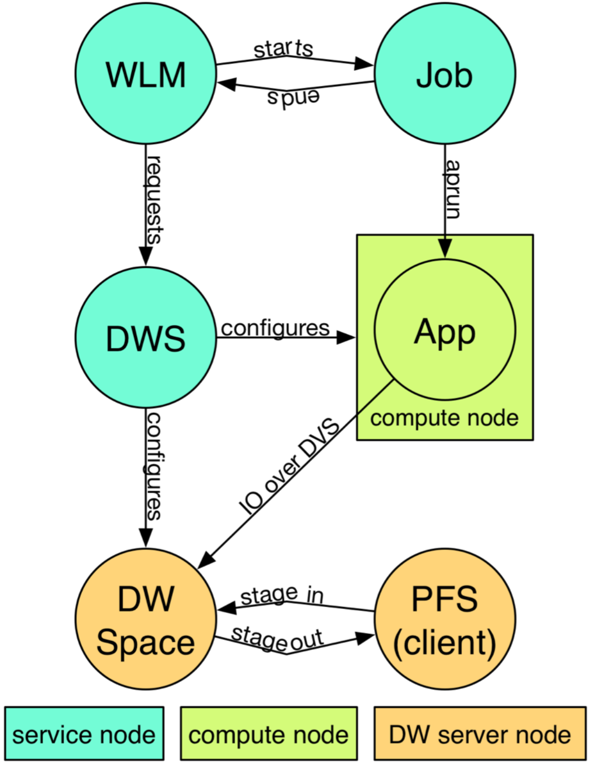
- DataWarp Background
- Transparent Cache
  - Usage
  - Data Path software
  - Orchestration software
- Early Results

DataWarp Overview

- **DataWarp is an *IO Accelerator***
  - Higher bandwidth, lower latency
- **Uses fast SSDs to absorb and serve IO faster than capacity-provisioned Parallel File Systems (PFS)**
- **Integration with workload managers enables users to tune DataWarp on a per-job basis**
  - PBS, Moab/TORQUE, Slurm

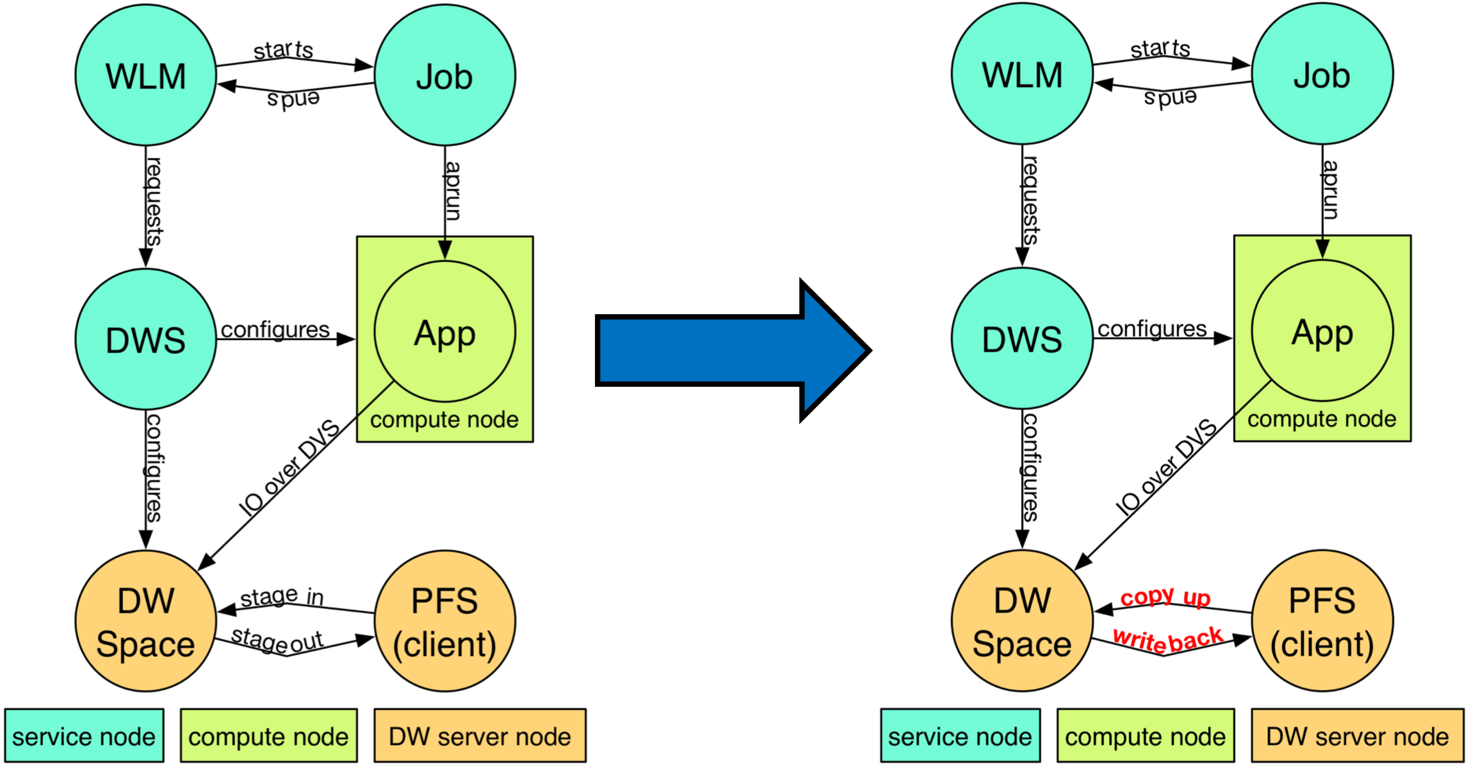
- **Existing scratch environment requires users to explicitly manage data transfer between the PFS and SSDs**
  - Start off with an empty filesystem
- **With the new transparent caching environment, DataWarp manages data transfer automatically**
  - Start off with a filesystem that looks like lustre, but faster
  - Easier to use, easier to get started

Basic DataWarp (scratch)



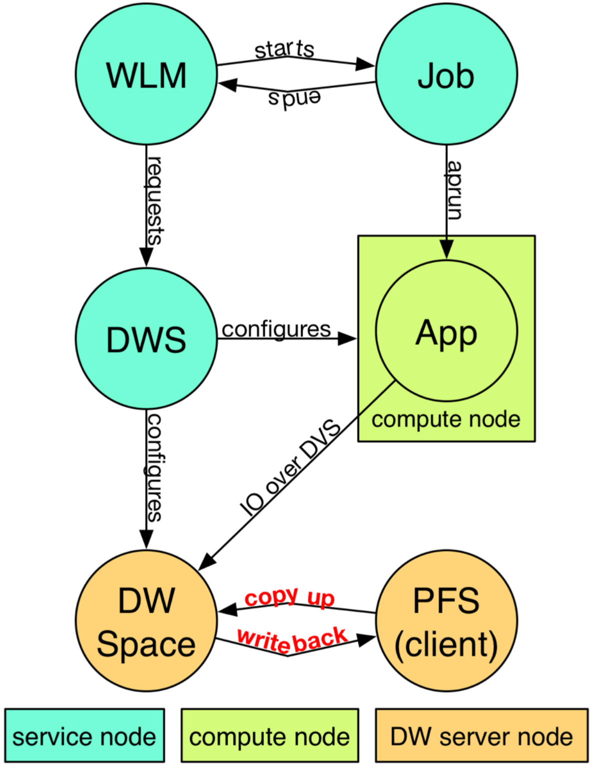
- WLM queues job, requests DWS set up job for using DW
- DataWarp Service (DWS) configures DW space, compute node access to DW
  - DW space is striped across one or more DW servers
- DataWarp File System handles data transfer interactions with PFS
  - Staging, like copy
  - User-initiated
- Compute nodes access DW via a mount point

Basic DataWarp (scratch -> cache)



Basic DataWarp (cache)

- Similar to scratch
- DataWarp File System handles data transfer interactions with PFS
  - Automatic
  - User just does IO



Using Transparent Cache

- **Primary method of user interaction**
  - Batch job script directives
  - DataWarp mount point
- **User specifiable attributes in batch job script directives**
  - PFS path to be transparently accelerated
  - Buffer capacity
- **Using the DataWarp mount point**
  - Environment variable available to batch job script contains the DataWarp path of the transparent caching filesystem
  - *ls* on DataWarp path looks like *ls* on lustre path

User Job Examples (Slurm, scratch comparison)

Without DataWarp

```
#!/bin/bash
#SBATCH --ntasks 3200

export JOBDIR=/lus/global/my_jobdir
srun -n 3200 a.out
```

With DataWarp Scratch

```
#!/bin/bash
#SBATCH --ntasks 3200
#DW jobdw type=scratch access_mode=striped capacity=1TiB
#DW stage_in type=directory source=/lus/global/my_jobdir destination=$DW_JOB_STRIPED
#DW stage_out type=directory source=$DW_JOB_STRIPED destination=/lus/global/my_jobdir

export JOBDIR=$DW_JOB_STRIPED
srun -n 3200 a.out
```

User Job Examples (Slurm, cache comparison)

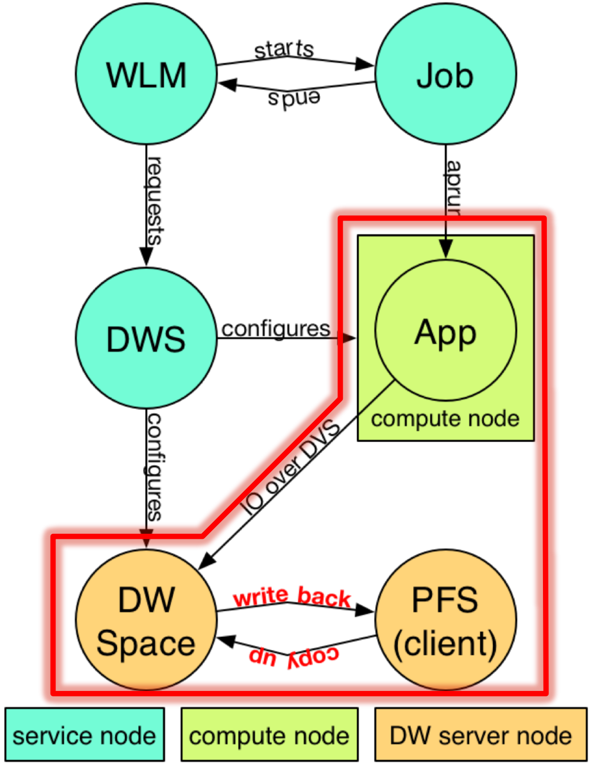
Without DataWarp

```
#!/bin/bash
#SBATCH --ntasks 3200

export JOBDIR=/lus/global/my_jobdir
srun -n 3200 a.out
```

With DataWarp Transparent Cache

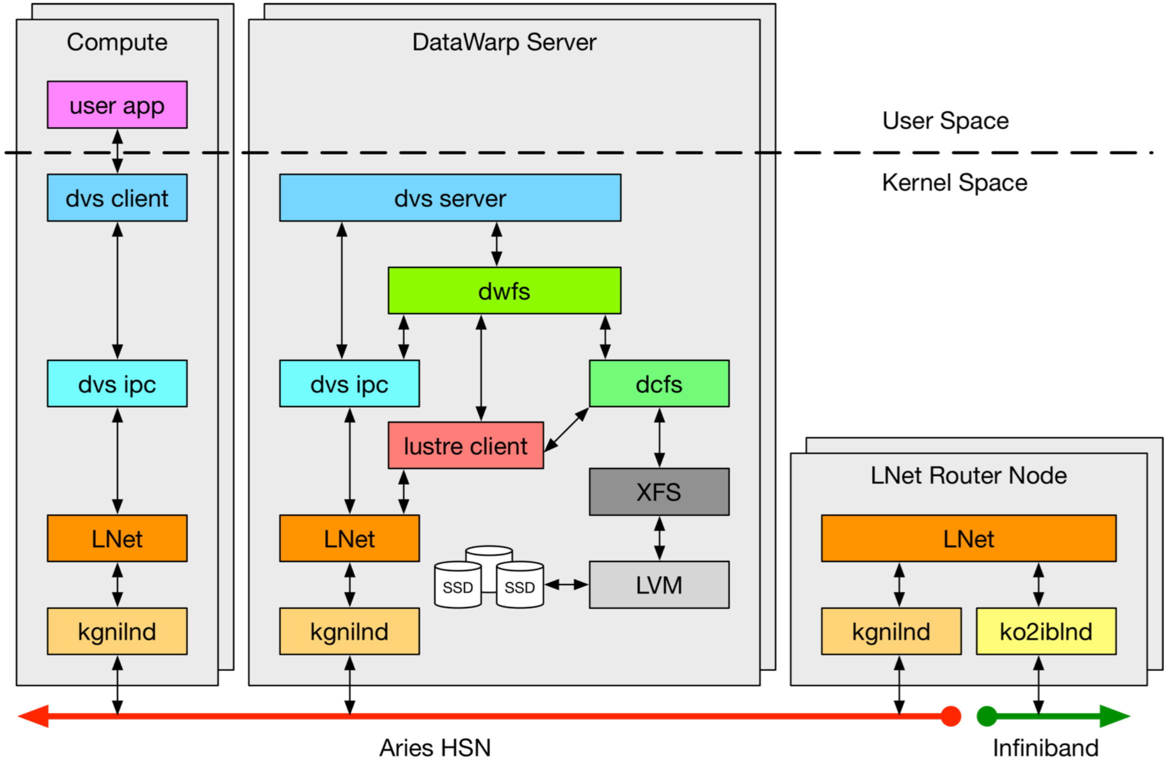
```
#!/bin/bash
#SBATCH --ntasks 3200
#DW jobdw type=cache access_mode=striped pfs=/lus/global capacity=10TiB

export JOBDIR=$DW_JOB_STRIPED_CACHE/my_jobdir
srun -n 3200 a.out
```

Transparent Cache Data Path

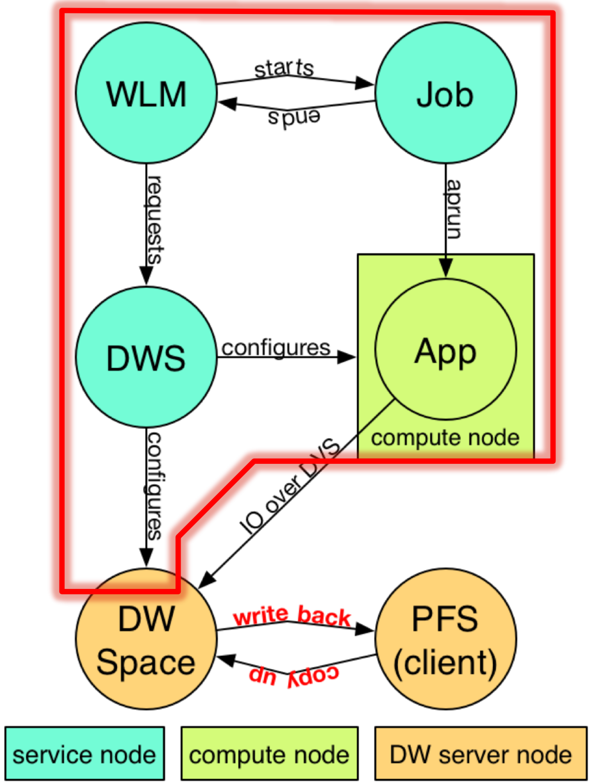


- **Compute nodes**
  - DVS client
- **DataWarp nodes**
  - DVS server
  - SSD space
  - DataWarp File System
  - Data Caching Filesystem
  - PFS client

Transparent Cache Data Path Interactions

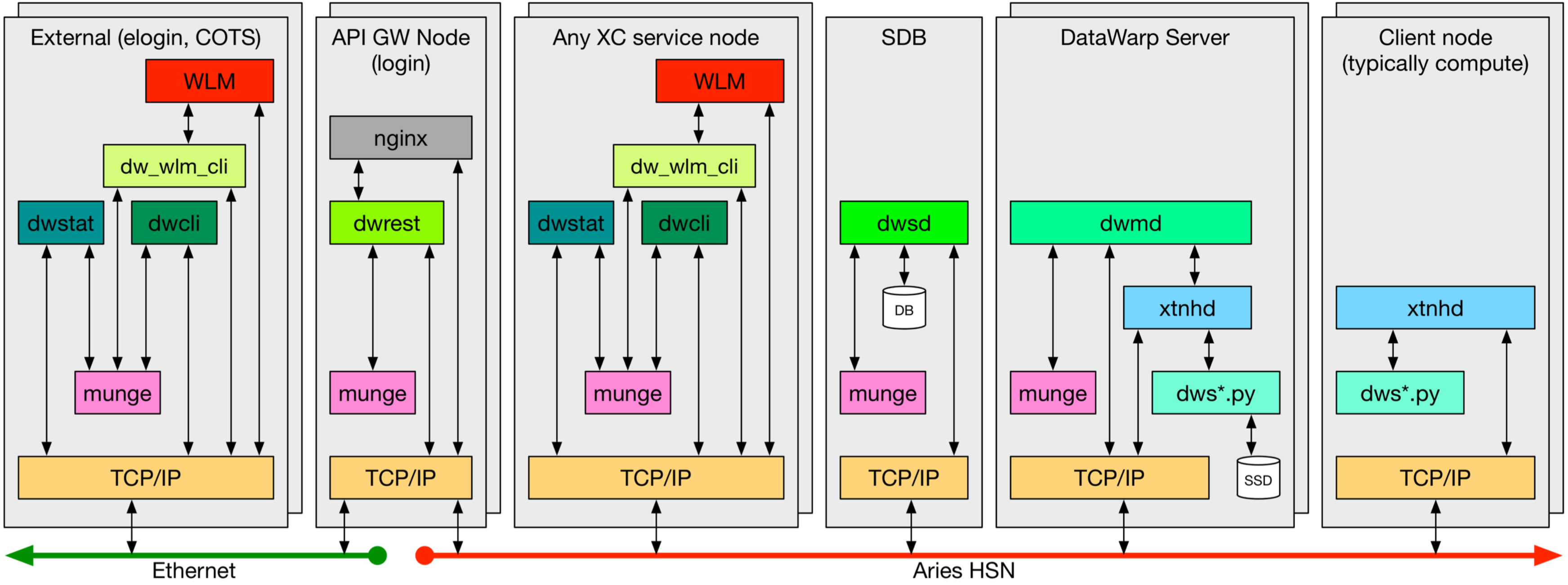


Transparent Cache Orchestration



- **Sets up and manages the data path**
- **Workload Managers**
- **DataWarp Service**
- **Node Health services**
  - Scalable fanout of commands
- **MUNGE**
  - Security

Transparent Cache Orchestration SW Overview



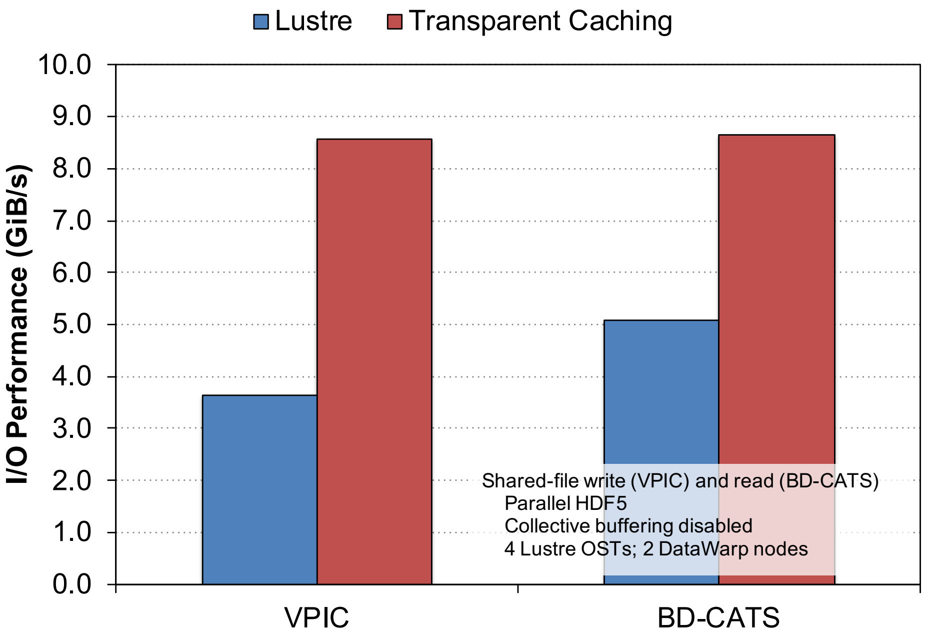
NERSC Early Results

- **Installation on Cori and extensive benchmarking has been overcome by other events**
  - Known limitations of early code were identified and understood
  - Anticipating GA release with UP06
  - Cori most likely will skip UP06 and target UP07
  - (UP05 installed week of 5/08)
- **Initially will be restricted to staff testing on Cori with alternate pool of (8) DataWarp servers (dev_pool)**
  - To isolate performance/failures from production pool

NERSC TDS Early Results

- **Initial Patch set applied to TDS (Gerty) at UP04**
  - Two DataWarp servers and smaller Lustre scratch
- **Branched image from Production cfgset and generated node images**
  - Used BTRFS ‘snapshot’ feature
- **‘Rolled Back’ for security patch installation (pre-Cori)**
- **TC Tested to be functional and stable**
- **TDS updated to UP05, Cray provided updated patch set, awaiting installation**

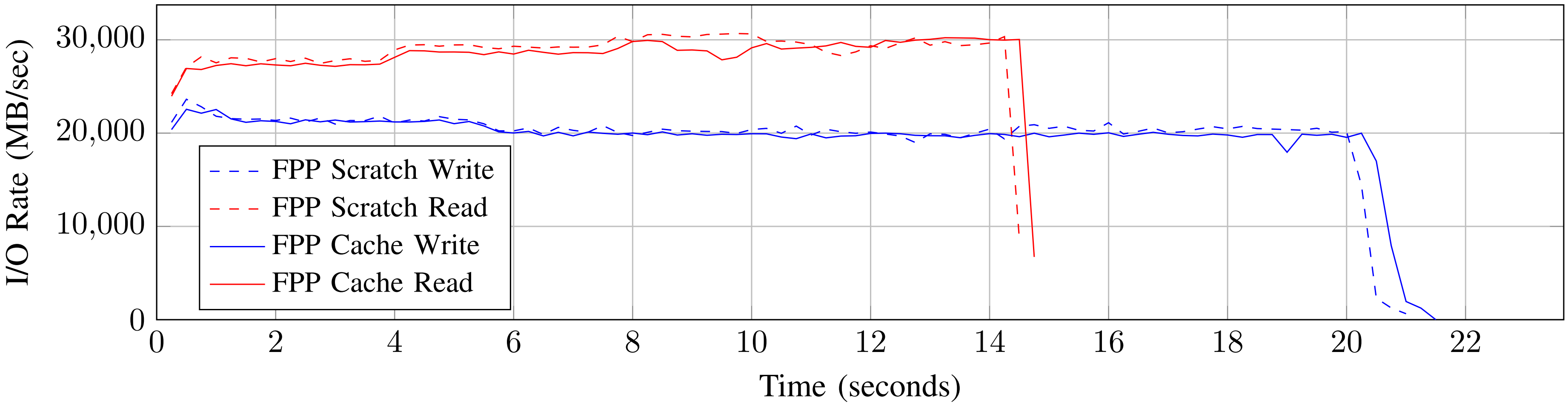
VPIC



Shared-file write (VPIC) and read (BD-CATS)
Parallel HDF5
Collective buffering disabled
4 Lustre OSTs; 2 DataWarp nodes

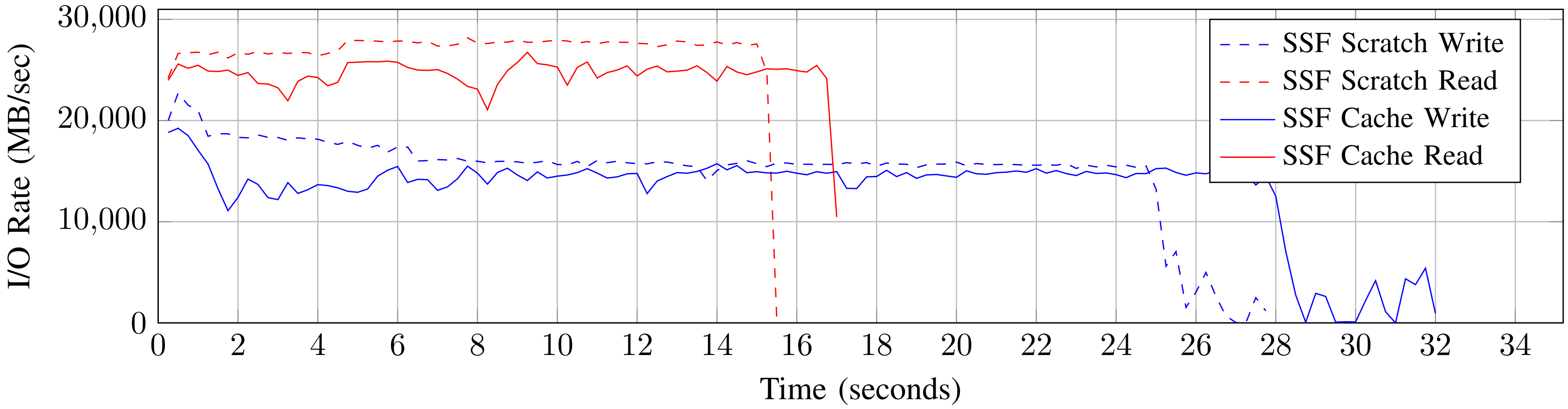
(Courtesy Glenn Lockwood – NERSC)

Early Results: Scratch vs Cache FPP



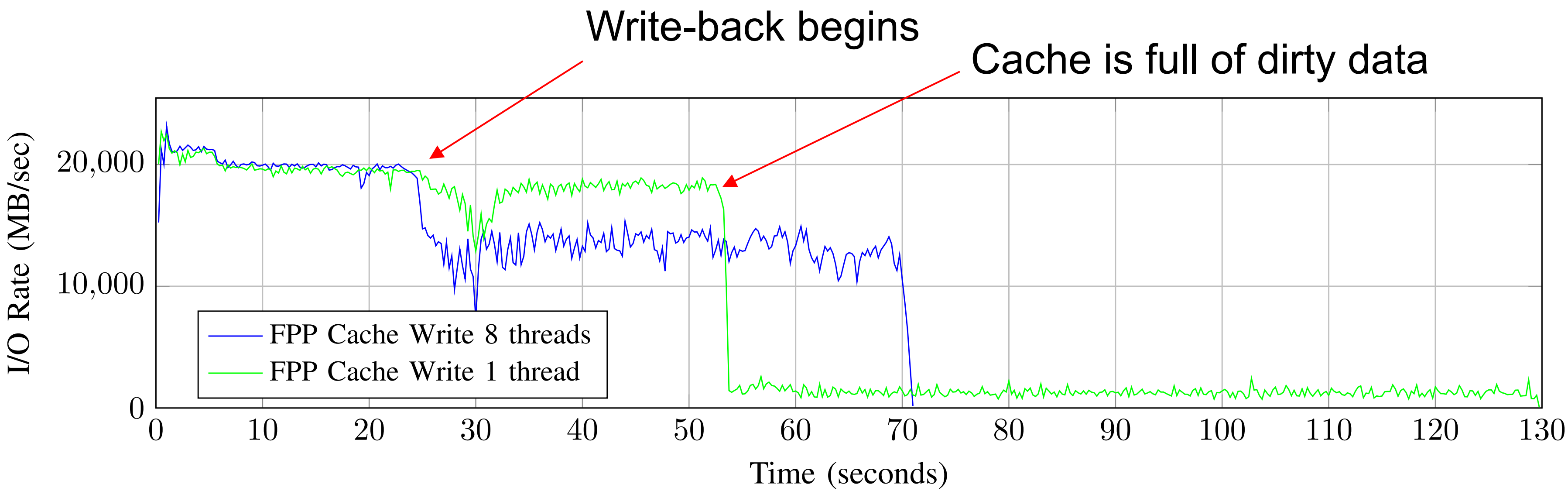
Cache is 2.2% slower for writes, 2.2% slower for reads

Early Results: Scratch vs Cache SSF



Cache is 13.4% slower for writes, 9.9% slower for reads

Early Results: 1 vs 8 write-back threads



Performance when write-back begins and when cache fills

Recap

- DataWarp Transparent Caching is in CLE 6.0.UP06
- Usability is improved over Scratch
- Transparent Cache data path re-uses all of the Scratch components
- Orchestration components are also re-used
- Early results are promising

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Q&A

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