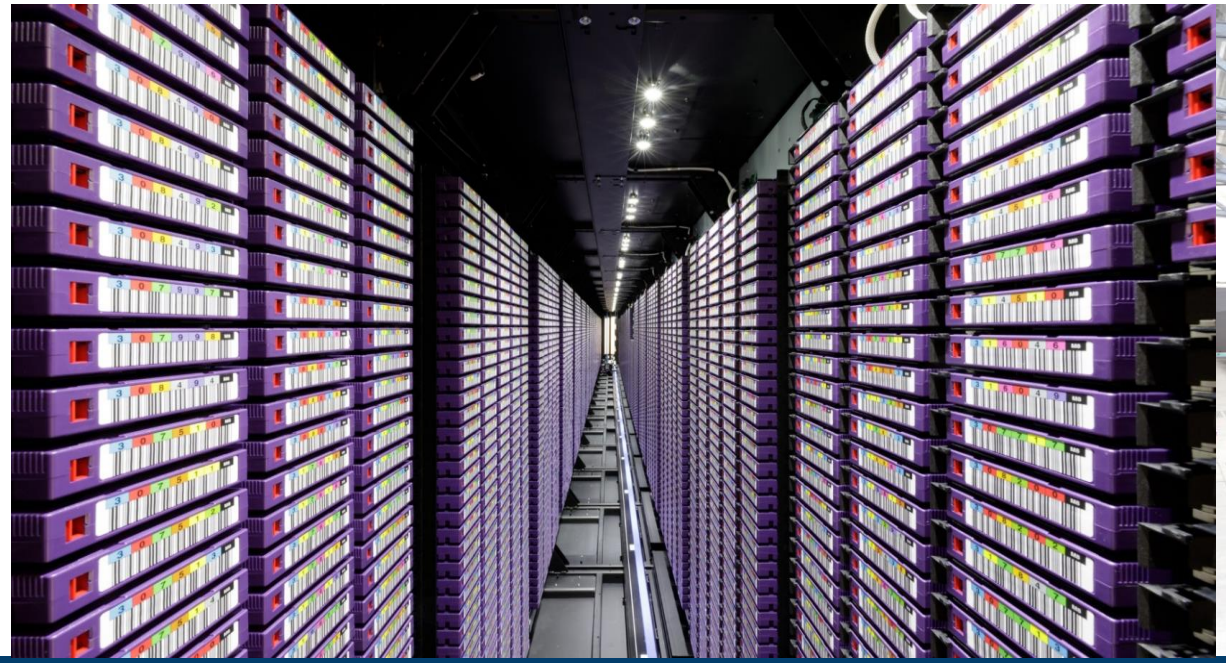
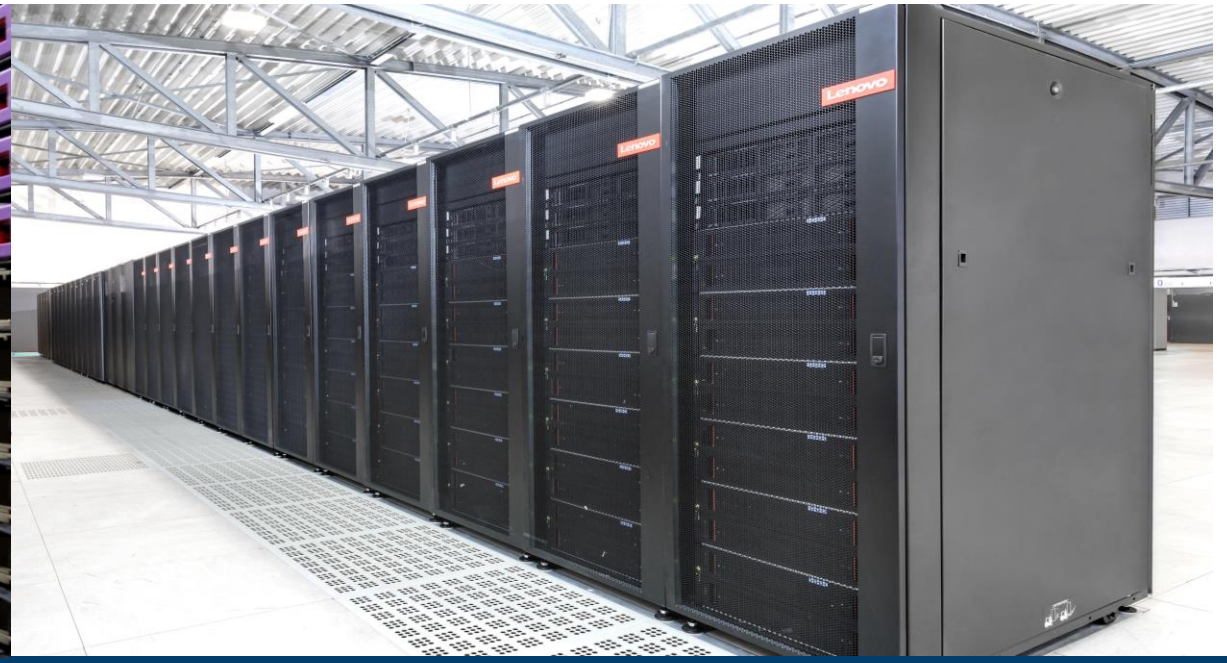


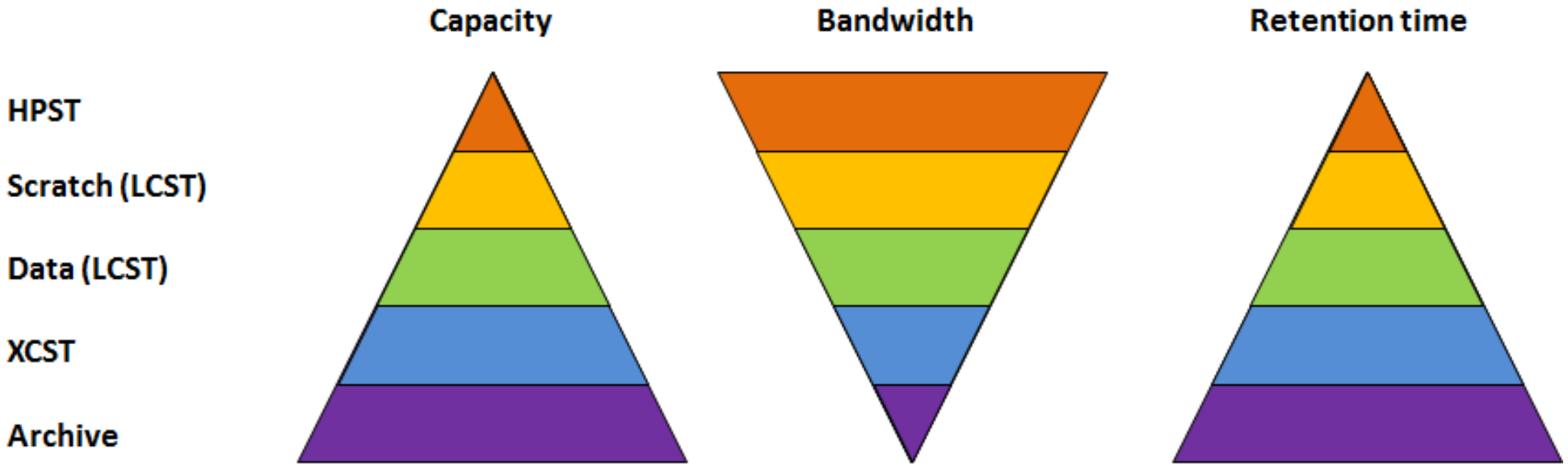


JUST

JÜLICH STORAGE CLUSTER

20. NOVEMBER 2023 I STEPHAN GRAF (JSC)

TIERED STORAGE OFFERING



- High Performance Storage Tier (HPST): NVMe based Storage (low latency+high bandwidth)
- Large Capacity Storage Tier (LCST): Lenovo DSS Cluster (GNR, 5th Gen. of JUST, bandwidth optimized) → LCST
- Extended Capacity Storage Tier (XCST): GPFS Building Blocks (target: capacity) → XCST
- Archive: Tape storage (Backup + GPFS&TSM-HSM)

JUST CLUSTER(S)

Key Characteristics

- File system access: parallel, POSIX compliant
- No user login
- Cross mounted on HPC systems
- One global namespace

HPST	LCST	XCST	ARCHIVE
NVMe based Cache	Spinning Disc bandwidth optimized	Spinning Disc Capacity optimized	Tape
110 server	22 Building Blocks	8 Building Blocks	1 Building Block 4 Tape Libraries
1.100 NVMe drives (2TB)	7.500 x 10TB Discs	8.000 Discs (10TB, 12TB, 16TB)	>40.000 Tapes (8TB – 18TB)
2.2 PB (raw)	75 PB (raw)	~95 PB (raw)	>380 PB
Infinite Memory Engine	Spectrum Scale (GPFS)+ GPFS Native RAID	Spectrum Scale (GPFS)	Spectrum Scale + Spectrum Protect (GPFS + TSM-HSM)

CENTRALIZED STORAGE

JUWELS + JUWELS Booster

DEEP

JUST

JURECADC

JUDAC

JUSUF

HPC USAGE MODEL @ JÜLICH

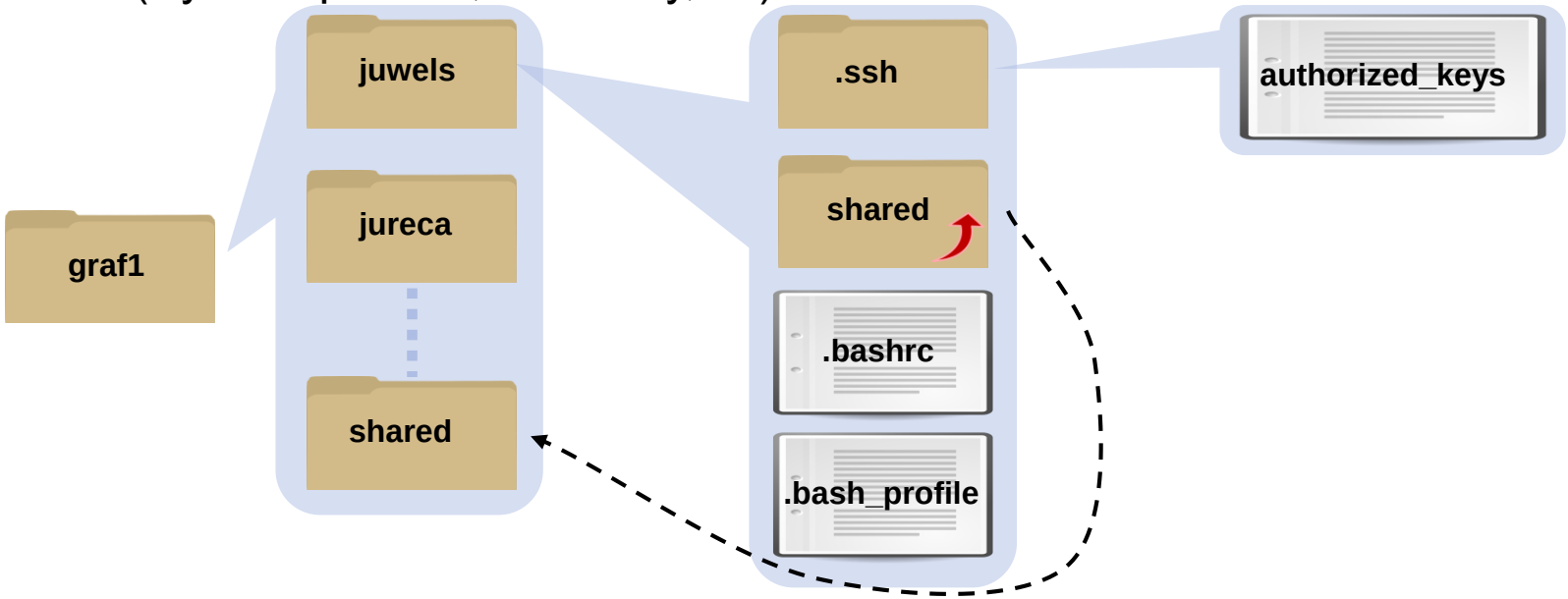
Key Characteristics

- One account per user: surname# (# is a consecutive number)
- Separation of user and project data - user must be joined to project to get access
- Data owner is the project
- Two project types: Compute + Data
- Project membership realized by UNIX groups
  - User's primary group: jusers
  - User's secondary groups: <list of project groups user is joined>
  - Files/directories created in project directory belongs to project group, realized by setGID bit: drwxrws---

    !! Owner can overrule it !! (`chown`, `rsync`, `cp -pR`, ...)
- Project Quota accounted on directory base

USER DIRECTORY (HOME)

- Path: **`/p/home/juser/<userid>`**
- **Small quota per user: 20 GB + 80.000 files**
- Data is in **Backup**
- Store your personal data (System profiles, SSH Key, …)
- For user **`graf1:`**



- Separate HOME on each system, e.g. on JUDAC: **`$HOME`** = **`/p/home/jusers/graf1/judac`**
- Link to **`shared`** folder

SCRATCH DIRECTORY

Compute Project

- Bandwidth optimized
  - JUST is capable of >300 GB/s
  - JURECA and JUWELS can achieve up to 200 GB/s by design
- Belongs to compute project
- Path: **`/p/scratch/<group>`**
  `$SCRATCH` = **`/p/scratch/cjsc`**
- Temporary files, checkpointing
- **Default Quota per group: 90 TB + 4 million files**
- **No Backup**
- **!!!Data deleted after 90 days without access!!!**
- Empty directories are deleted after 3 days

HPST: CACHE LAYER FOR $SCRATCH

Compute Project

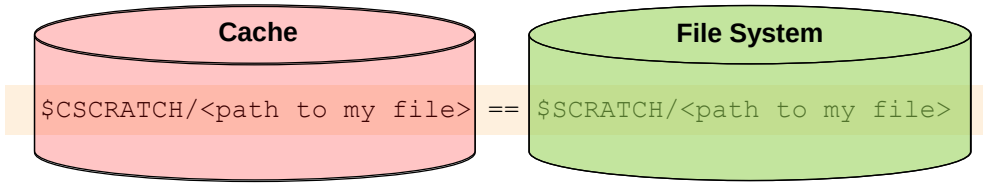
- High Bandwidth & Low Latency, optimal for “hard” IO pattern like small random access
- Available on JUWELS, JURECADC and JUSUF
- Compute project proposal must point out it’s requirements (depends on IO pattern)
- Path: **`/p/cscratch/fs/<group>`** → is a mapping to **`/p/scratch/<group>`**
  `$CSCRATCH` = **`/p/cscratch/fs/cjsc`**
- Access realized by additional secondary group
- **POSIX access (fuse) and native interface**
- **Quota per project: 20 TB (soft quota)**
- **Global namespace**
- **Data staging**

Slize	size	Bandwidth*
JUWELS	1036 TB	1024/600 GB/s
JURECADC	844 TB	800/600 GB/s
JUSUF	230 TB	240/220 GB/s
Total	**2110 TB**	**2064/1420 GB/s**

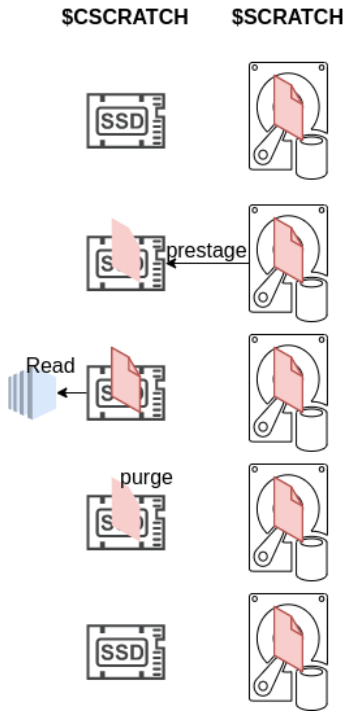
- EOL Q2/2024
- Remove access restriction
- Contact JSC application support

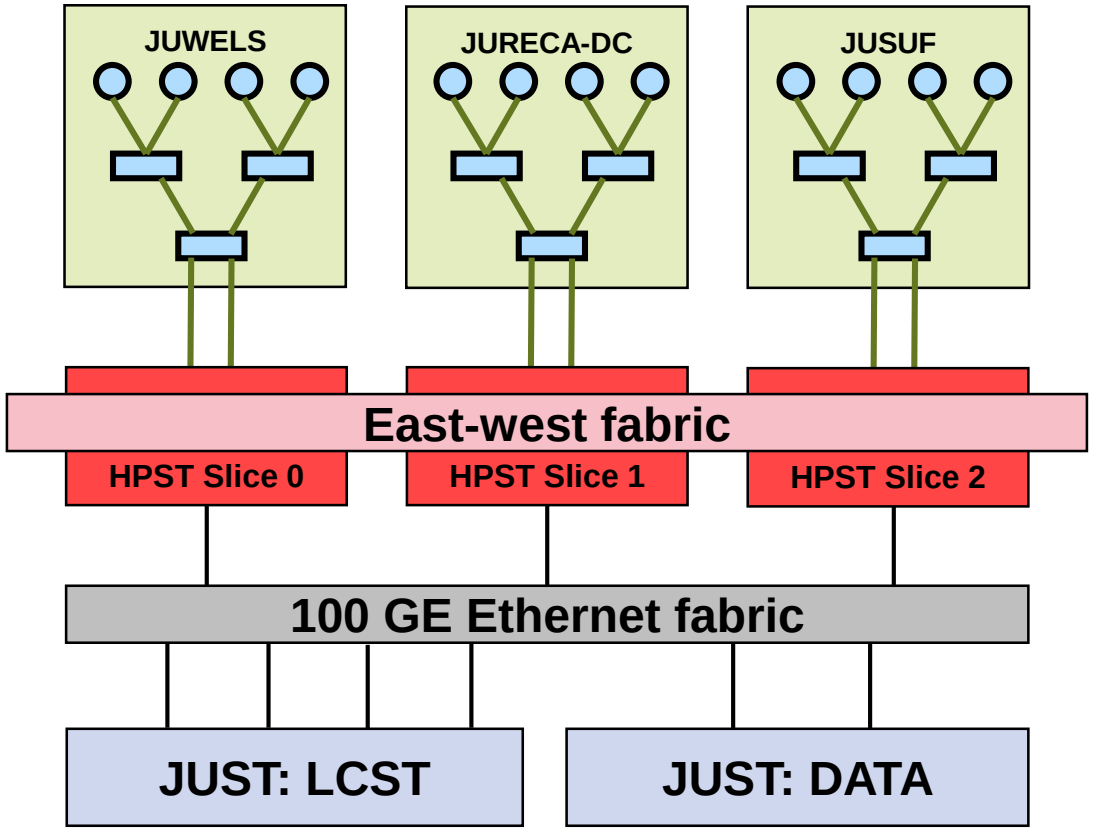
HIGH PERFORMANCE STORAGE TIER

Usage scenarios



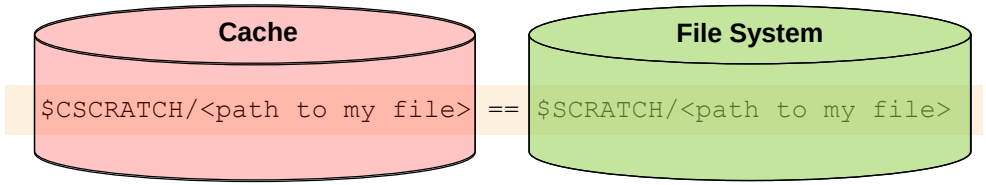
1. **Read file using HPST**



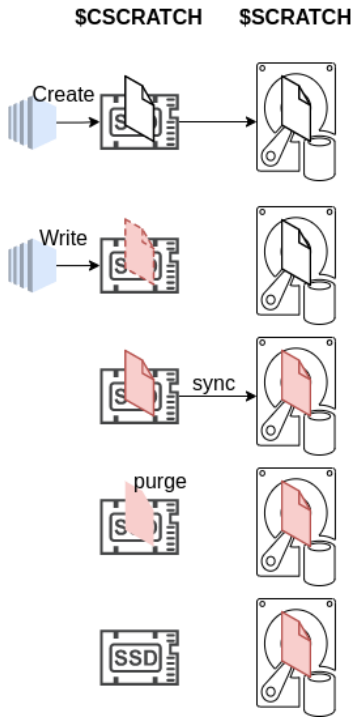


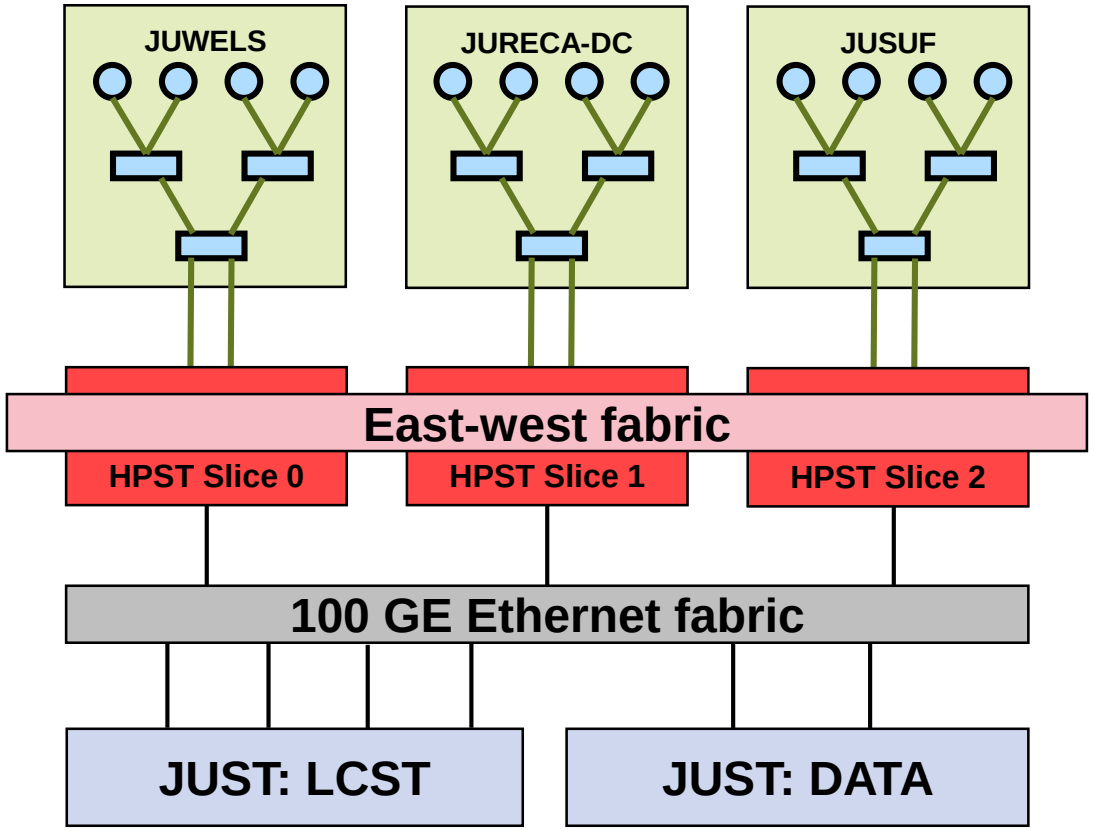
HIGH PERFORMANCE STORAGE TIER

Usage scenarios



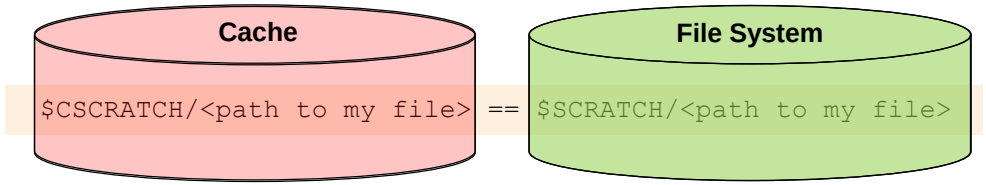
2. **Write new file to HPST**



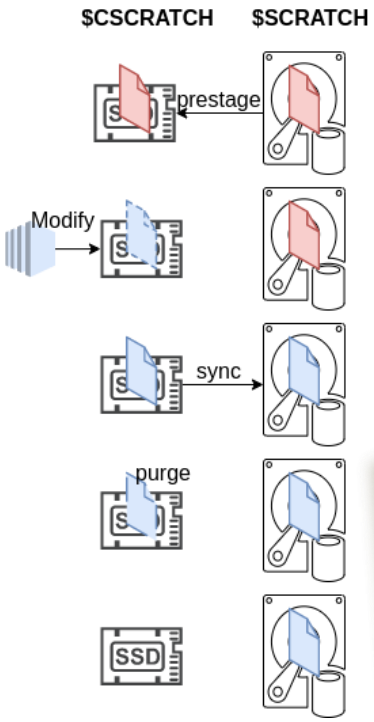


HIGH PERFORMANCE STORAGE TIER

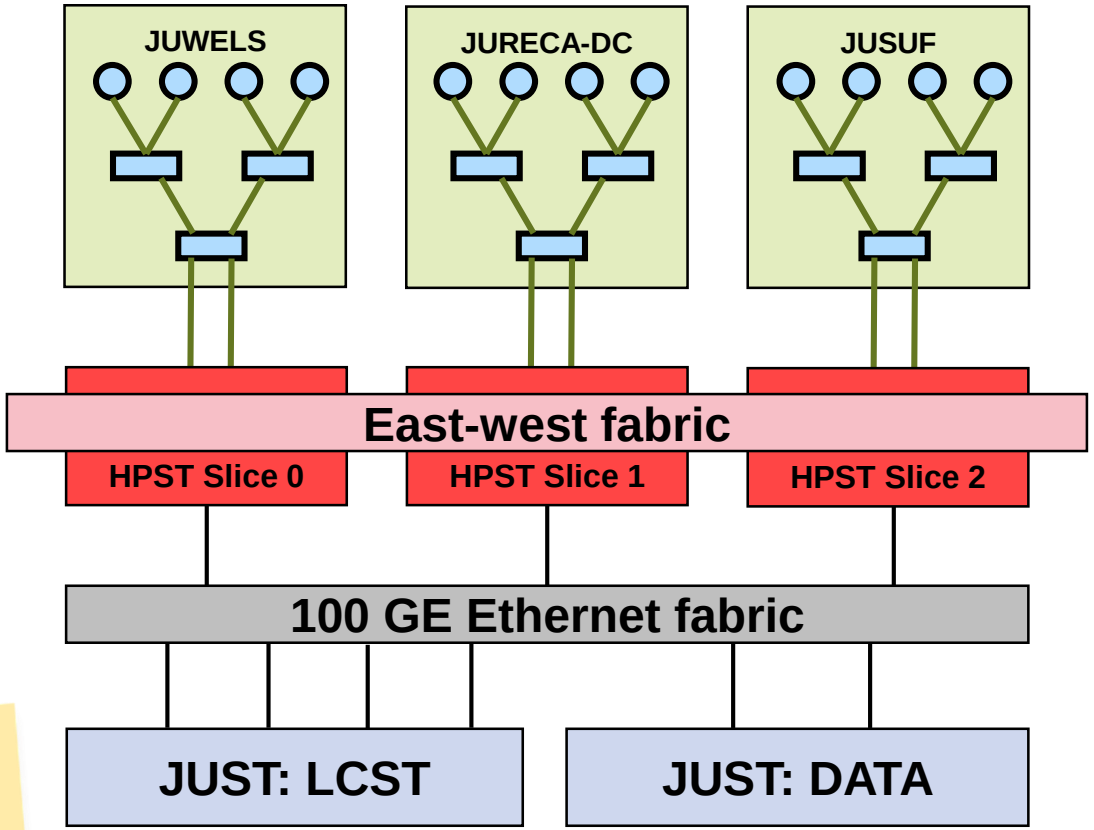
Usage scenarios



3. **Read and modify file using HPST**



In preparation:
IO statistics
included in job reporting



PROJECT REPOSITORY

Compute Project

- Data repository for the compute project
  Path: **`/p/project/<group>`** e.g: **`$PROJECT`** = **`/p/project/cjsc`**
- Default Quota: 16 TB / 3 Mio inodes (files)
- Data is backed up
- Lifetime depends on project time span ➡ longterm storage/archiving can be realized by a ***data project***

FASTDATA REPOSITORY

Data Project

- High Bandwidth (close to $SCRATCH)
- Data project proposal must point out it's requirements for *FASTDATA*
- Path: **/p/fastdata/<group>** e.g: **`$FASTDATA`** = **`/p/fastdata/zam`**
- **Quota per group: as granted to project**
- Data is backed up

LARGEDATA REPOSITORY

Data Project

- Separate storage cluster (XCST)
- High Capacity (disk based)
- Data project proposal must point out it's requirements for *LARGEDATA*

Repository Type: File System

- Path: **/p/largedata[2]/<group>**
  `$DATA = /p/largedata/zam`
- **Quota per group: as granted to project**
- **Data is backed up**
- **Data sharing to Community/World by VM** (on request)

Repository Type: Object Storage

- Supported protocols: **OpenStack Swift** and **S3**
- **Client environment on JUDAC available**
  https://apps.fz-juelich.de/jsc/hps/just/object-storage.html
- **Backup: Disaster Recovery**

ARCHIVE REPOSITORY

Data Project

- Filesystem consist of 2 tiers: disks (cache) and tapes (long term)
- Path: `/p/arch[2]/<group>`
  $ARCHIVE = /p/arch/zam
- Archive your results
- Only available on login
- **Quota per group: as g**
- **Data are in Backup**
- Special rules:
  - Files > 7 days are migration candidate → moved to tape
  - Recall per file is expensive (1 minute mount time + 100 MB/s)
    → **use (zipped) tar balls > 1TB**
  - **Avoid renaming of directory structures** (may trigger huge recalls)

```
[zdv124@judac01:/p/arch/zam/zdv124> ls -lisah
total 320K
  407977  128K drwx------   2 zdv124 zam   64K May 18 10:01 .
  407555  128K drwxr-xr-x 316 root   sys   64K May 24 15:00 ..
18062260   64K -rw-r--r--   1 zdv124 zam     5 Sep  2  2011 datum.txt
12920848     0 -rw-r--r--   1 zdv124 zam   12G Jun  3  2015 Vervet_s0050_tiff.tgz
```

FILESYSTEMS - SUMMARY

File System	Shell Variable	Description	Project Type	Characteristics
home	**$HOME**	Users HOME File Systems		User Quota: 10GB/40.000 Files Files in Backup
project	**$PROJECT**	Compute Project File System	Compute	Group Quota: 16TB/3Mio Files Files in Backup
scratch	**$SCRATCH**	Compute Project Scratch File System	Compute	Group Quota: 90TB/4Mio Files Files deleted after 90 days
cscratch	**$CSCRATCH**	Fast cache for scratch file system	Compute	Group Quota: 20TB Data staging required
fastdata	**$FASTDATA**	High Bandwidth and large Capacity File System	Data	Group Quota: depends Files in Backup
largedata	**$DATA**	Large Capacity (Disk based)	Data	Group Quota: depends Files in Backup
arch arch2	**$ARCHIVE**	Archive File System (Tape)	Data	Group Quota: depends Files in Backup Migration to tape

JUDAC – JUELICH DATA ACCESS

Data access and transfer cluster

- All HPC user can login on judac: `ssh <userid>@judac.fz-juelich.de`
- Independent from HPC systems (e.g. in maintenance)
- Access to Jülich Object Storage: openStackClient
- Purpose: data transfer in & out the HPC filesystems
  - **`scp`**, **`rsync`**
    - Standard ssh setup can be used (connection must be initiated from external)
    - Use **`screen`** or **`tmux`** for long running data transfer
  - jutil
  - Grid Tools
  - UNICORE FTP (next slide)
- For more information go to → JUDAC Web Page

DATA TRANSFER TO/FROM JÜLICH USING UNICORE

- Install client from sourceforge on your system (1x)
- Create client SSH key (1x)

```
[user@home ~]$ mkdir -p $HOME/.uftp
[user@home ~]$ ssh-keygen -a 100 -t ed25519 -f $HOME/.uftp/id_uftp
```

- Prepare client environment (1x)

```
[user@home ~]$ export UFTP_USER=<your_remote_user_id>
[user@home ~]$ export UFTP_AUTH_URL=https://uftp.fz-juelich.de:9112/UFTP_Auth/rest/auth/JUDAC:
[user@home ~]$ export UFTP_KEY=$HOME/.uftp/id_uftp
```

- Copy public key to JUDAC (UNICORE server) (1x)

```
[user@home ~]$ ssh $UFTP_USER@judac.fz-juelich.de 'mkdir -p $HOME/.uftp'
[user@home ~]$ scp $HOME/.uftp/id_uftp.pub $UFTP_USER@judac.fz-juelich.de:.uftp/authorized_keys
```

- Upload/download data

```
[user@home ~]$ uftp cp --user $UFTP_USER --identity $UFTP_KEY "file.tar" $UFTP_AUTH_URL/p/home/jusers/$UFTP_USER/jureca
[user@home ~]$ uftp cp --user $UFTP_USER --identity $UFTP_KEY $UFTP_AUTH_URL/p/home/jusers/$UFTP_USER/juwels/file.tar .
```

DATA SHARING INSIDE JÜLICH HPC

Different use cases and solutions for sharing data between users:

1. **Use compute project repository ($PROJECT)**
   Any user can be joined to project without access to project‘s compute resources
2. **Use data project**
   Members of different compute projects can join a common data project
3. **Single files**
   All users can access common directory „**`$SCRATCH/../share`**“. Remember the automatic file deletion after 90 days!
4. **Software project**
   Special data project which is mounted on compute nodes

HINTS & TIPS

- Create **checksum** on data files
- Restore files from backup: **`adsmback`**
  - **available only on JUDAC**
  - Calls IBM TSM Backup/Restore GUI
  - Hard to guaranty daily backup → snapshots available, eg: **`$PROJECT/../.snapshots/daily-YYYYMMDD/<project>/`**
- Quota usage information: **`jutil`**
  - Project group quota info: **`jutil project dataquota -p <project>`**
  - User quota info: **`jutil user dataquota -u <user>`**
- SSH/SCP usage
  - Multiple external (scripted) access can be classified as an attack → Firewall will block external IP
  - Outgoing SSH is blocked!
- Take care of your files
  - No special characters in filenames (newline, tab, escape, …)

AND FINALLY

- **Filesystem status:** https://status.jsc.fz-juelich.de/
- **JUST web pages (e.g. FAQ)** https://go.fzj.de/JUST
- **JUDAC web pages (e.g. data transfer, object store)** https://go.fzj.de/JUDAC
- Jülich HPC Usage Model: http://www.fz-juelich.de/ias/jsc/usage-model
- JuDoor – manage accounts/projects, overview of resources, … http://www.fz-juelich.de/ias/jsc/judoor
- For any problem (accessing files, access rights, restore, quota, data transfer, …) contact JSC application support (**sc@fz-juelich.de**)
- If you want to optimize your application IO:
  - What is the access pattern?
  - Use IO libraries/formats HDF5, MPI-IO, SIONLIB, …
  - Contact JSC application support (**sc@fz-juelich.de**)

OUTLOOK 2024

- Current JUST hardware will be replaced (no interruption)
- Planning to restructure the setup (small maintenance(s) necessary)
- Installation of the Exascale system **JUPITER**
  - Separate storage cluster **EXASTORE**
  - NVMe based storage cluster **EXAFLASH**
- New **datamover service**
  - Move/copy data between
    - EXAFLASH ⟷ EXASTORE
    - EXASTORE ⟷ JUST
  - Slurm integration