DPM storage migration and EOL

Petr Vokáč (CTU, EGI), Jiří Chudoba (FZU), Alexandr Mikula (FZU)

HEPiX

3rd November 2022

DPM End-Of-Life

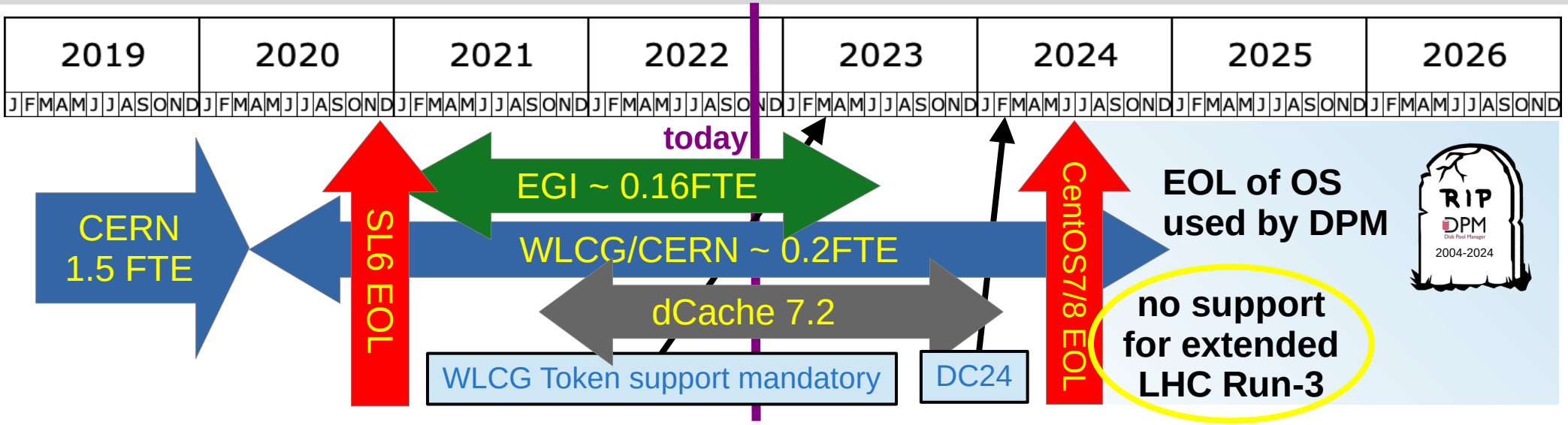
EGI support till June 2023

CERN supporttill summer 2024

⇩

DPM storage migration

DOME DPM support



- **WLCG / CERN – March 2020 GDB** The DPM Collaration
  - support till the **end of LHC Run-3**, but since this announcement
    - CentOS8 EOL changed
    - LHC Run-3 extended
    - no DPM for supported OS
    - no new features
- **EGI – provide dCache (7.2) migration tools**
  - help sites to migrate **DPM to dCache**
  - interested DPM sites should ***move before summer 2023***
  - reduced time for solving DPM issues not related to migration

DPM Evolution

2004 LCGDM

⇩

2012 dmlite

⇩

2016/9 DOME

⇩

2022 “dCache” ⇦ ?

Migration strategy

- a) site stop providing “grid storage”
  - consolidation of storage sites
  - disk-less / cache only site (small sites)

HEPiX 2020 survey

} good network connectivity

- b) copy all data to the new storage
  - straightforward, but slow and require additional (local) space
  - significant effort from local and also central ops team
  - gives full flexibility choosing new storage technology
    - e.g. in erasure encoding (HEPiX Erasure Encoding WG?)
  - operate multiple sites as one storage (complexity by central team)
- c) ***migration without moving data transparent to the clients***
- Biggest DPM users presented plans at the WLCG GDB (DC24)
  - disk-less, consolidate, **dCache**, EOS, CEPH
  - different plans even within same country / cloud
  - small sites without dedicated SE admin prefers simple solutions

DPM to dCache migration

- In-place dCache migration is just **one of available options**
  - sites should consider their future plans first
  - provide easy migration path to the compatible storage

CentOS7 and newer required for headnode and diskhodes **after migration** (~20% still rely on SL6)

- Transparent migration
  - ***Migrate*** just ***catalog*** (database) and keep ***files untouched***
    - both SE store files on ***posix filesystem***

no direct migration from **legacy DPM**

- No visible difference for clients (Rucio, FTS, gfal2, …)
  - dCache can easily match DPM features & provide more
    - sometimes with slightly more complex configuration
  - same protocols (HTTPS, xroots, gsiftp, SRM)
  - same hosts:ports / firewall configuration (almost)
  - same authentication (X.509, +tokens), different WLCG SRR location

make ***migration*** as ***simple*** as legacy to DOME DPM transition

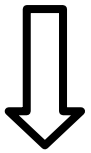
- ***dCache DPM replacement transparent for end users / VOs***
  - **Goal: 1 day downtime DPM → dCache migration**

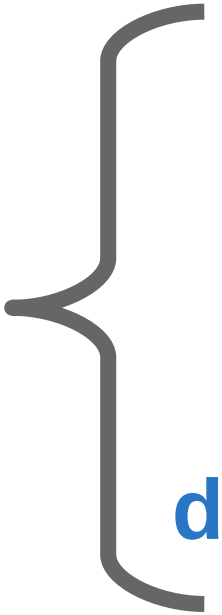
Storage migration in three steps

online

DPM consistency updates

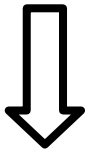
several days / weeks





downtime

DPM dump



dCache import

~ day

https://twiki.cern.ch/twiki/bin/view/DPM/DpmDCache

Migration steps in more details

- Online DPM consistency checks / fixes with dmlite-shell (4 steps)
  - meanwhile install (minimal) python3 **`migrate.py`** dependencies
- Stop DPM & export namespace and config
  - meanwhile install dCache 8.2 on all DPM machines
  - install PostgreSQL database and create user and databases
- Generate dCache configurations from exported **`config.csv`**
  - optionally modify user & group mapping and path attributes
    - useful for cleaner dCache configuration
  - distribute generated dCache configuration files
  - temporarily start dCache on headnode → init. db tables
- Import **`namespace.csv`** dump in dCache PostgreSQL
  - Import create data files used later on disknodes to link (move) file from DPM to dCache physical location on posix filesystem
- Start dCache services + cleanup DPM (files, MySQL db, packages)

!!! terminated import can't be re-tried without cleanup

Migration commands for hosts

```
dpmheadnode$ dmlite-shell --log-level=INFO --log-file=/tmp/dpm-lost-and-dark.log -e 'dbck lost-and-dark-show script' > /tmp/dpm-lost-and-dark.sh
dpmheadnode$ sh /tmp/dpm-lost-and-dark.sh
dpmheadnode$ dmlite-shell --log-level=DEBUG --log-size=104857600 --log-file=/tmp/dpm-dbck.log -e 'dbck dpm-dbck update'
dpmheadnode$ dmlite-shell --log-level=DEBUG --log-size=104857600 --log-file=/tmp/dpm-dbck.pool-file.log -e 'dbck pool-file update nthreads=8'
dpmheadnode$ dmlite-shell --log-level=INFO --log-size=104857600 --log-file=/tmp/dpm-dbck.fill-checksum.log -e 'dbck fill-checksum update nthreads=25'
# declare downtime & stop DPM services
dpmheadnode$ systemctl stop httpd rfiod srmv2.2 dpnsdaemon dpm dpm-gsiftp xrootd@dpmredir
dpmheadnode$ systemctl disable httpd rfiod srmv2.2 dpnsdaemon dpm dpm-gsiftp xrootd@dpmredir
dpmdisknodes$ systemctl stop httpd rfiod dpm-gsiftp xrootd@dpmdisk
dpmdisknodes$ systemctl disable httpd rfiod dpm-gsiftp xrootd@dpmdisk
dpmdbnode$ python3 migrate.py --log-level=DEBUG --log-file=dpm-dump.log --dpm-export --dpm-dbhost=dpmdb.fqdn --dpm-dbuser=dpmdb_user --dpm-dbpasswd=dpmdb_secret
# generate dCache configuration files from config.csv created in previous step
dcachedbnode$ python3 migrate.py --log-level=DEBUG --log-file=migrate-dcache-config.log --dcache-config
# install dCache and its database & distribute dCache configs to /etc/dcache on all storage nodes
dcacheheadnode$ yum install -y https://www.dcache.org/downloads/1.9/repo/7.2/dcache-7.2.16-1.noarch.rpm
dcacheheadnode$ alternatives --set java $(alternatives --display java | grep 'family java-11-openjdk' | cut -d' ' -f1)
dcacheheadnode$ chown dcache /etc/grid-security/hostcert.pem /etc/grid-security/hostkey.pem
dcacheheadnode$ mkdir /etc/systemd/system/dcache@.service.d
dcacheheadnode$ cat > /etc/systemd/system/dcache@.service.d/capabilities.conf <<EOF
[Service]
AmbientCapabilities=CAP_NET_BIND_SERVICE
EOF
dcacheheadnode$ ssh-keygen -C admin@localhost -t rsa -N '' -f id_rsa
dcacheheadnode$ cat /root/.ssh/id_rsa.pub > /etc/dcache/admin/authorized_keys2
dcacheheadnode$ scp dcache.conf gplazma.conf ban.conf ban.conf multi-mapfile.group multi-mapfile.user multi-mapfile.vo multi-mapfile.unmapped vo-group.json vo-user.json omnisession.conf LinkGroupAuthorization.conf
dcacheheadnode:/etc/dcache
dcacheheadnode$ scp layout-HEADNODE_FQDN.conf dcacheheadnode:/etc/dcache/layout
dcachedisknodes$ yum install -y https://www.dcache.org/downloads/1.9/repo/7.2/dcache-7.2.16-1.noarch.rpm
dcachedisknodes$ alternatives --set java $(alternatives --display java | grep 'family java-11-openjdk' | cut -d' ' -f1)
dcachedisknodes$ chown dcache /etc/grid-security/hostcert.pem /etc/grid-security/hostkey.pem
dcachedisknodes$ scp dcache.conf dcachedisknodes:/etc/dcache
dcachedisknodes$ scp layout-DISKNODE_FQDN.conf dcachedisknodes:/etc/dcache/layout
dcachedbnode$ yum install -y https://download.postgresql.org/pub/repos/yum/reporpms/EL-7-x86_64/pgdg-redhat-repo-latest.noarch.rpm
dcachedbnode$ yum install -y postgresql14-server
dcachedbnode$ /usr/pgsql-14/bin/postgresql-14-setup initdb
dcachedbnode$ cat > /var/lib/pgsql/14/data/pg_hba.conf <<EOF
# database on headnode
local   all             all                                     trust
host    all             all             127.0.0.1/32            trust
host    all             all             ::1/128                 trust
# database on dedicated dbnode
#host   chimera         dcache          192.0.2.123/32          md5
#host   spacemanager    dcache          192.0.2.123/32          md5
#host   pinmanager      dcache          192.0.2.123/32          md5
#host   srm             dcache          192.0.2.123/32          md5
EOF
dcachedbnode$ # enable connections to postgresql database from remote machines in case you use dedicated dbnode
dcachedbnode$ #perl -p -i -e "s/^#.*listen_addresses *= *'localhost'/listen_addresses = '*'/" /var/lib/pgsql/14/data/postgresql.conf
dcachedbnode$ systemctl enable postgresql-14
dcachedbnode$ systemctl start postgresql-14
dcachedbnode$ createuser -U postgres --no-superuser --no-createrole --createdb --pwprompt --no-password dcache
dcachedbnode$ createdb -U dcache chimera
dcachedbnode$ createdb -U dcache spacemanager
dcachedbnode$ createdb -U dcache pinmanager
dcachedbnode$ createdb -U dcache srm
# start dCache on headnode + configure linkgroups and space reservations + stop dCache on headnode
dcacheheadnode$ systemctl daemon-reload
dcacheheadnode$ systemctl start dcache.target
dcacheheadnode$ sleep 300 # wait for dCache start
dcacheheadnode$ cat admin-cli.psu | grep -v ^# | ssh -p 22224 -l admin localhost
dcacheheadnode$ sleep 300 # wait till PSU configuration gets propagated between dCache services
dcacheheadnode$ cat admin-cli.reserve | grep -v ^# | ssh -p 22224 -l admin localhost
dcacheheadnode$ systemctl stop dcache.target
dcachedbnode$ python3 migrate.py --log-level=DEBUG --log-file=migrate-dcache-import.log --dcache-import
dcachedisknodes$ python migrate.py --log-level=INFO --log-file=migrate-dcache-link.log --link --link-file=data-dpmdisk1.example.com.csv
# start dCache services on all storage nodes
# cleanup physical files from DPM locations and keep just new "dcache" subdirectory
```

Consistency

DPM dump

dCache import

DPM host cmds

- headnode (5)
- disknodes (2)
- dbnode (1)

dCache host cmds

- headnode (16)
- disknodes (6)
- dbnode (14)

Technically it is possible to revive DPM at any migration stage except after last cleanup step

Migration documentation

- Migration process described in the DpmDCache twiki
- Use recent dmlite packages from EPEL repository (UMD)
  - current release dmlite 1.15.2-11, available for CentOS7 & CS8
  - even minor update may safe your time
    - fixed issues with corner cases discovered during prod. site migration
    - more robust with respect to variations in DPM configuration
      - legacy DPM → define quotatokens → consistency → dCache

no SL6 support in dCache 7.2, 8.2

- Documentation improved since first migration
  - initially written based on steps done with testbed
    - migration tool development & testing
    - important details missing / not written in right order
  - integrated experience with migration of production storages
  - less manual steps, less error prone, more details
  - many steps – I also migrate our production DPM by following this doc

special characters correctly escaped

Migrated production sites

- Several prod sites successfully used dCache migration tools
- Different level of support during migration
- Namespace dump & restore takes significant time
  - can increase total downtime in case of problems
  - depends mainly on number of objects and PgSQL core performance
    - biggest known DPM instance at TOKYO – 8PB with 67M objects

only early adopters displayed in the table (more sites migrated since summer)

GOCDB site name	Date	Storage size [PB]	Storage objects [M]	Consistency updates [days]	DPM export [h]	dCache Import [h]	Downtime [h]
prague_cesnet_lcg2	February	0.6	2				~ 30*
TW-NTU-HEP (BelleII)	May						
praguelcg2	May 14	5.0	47	15	2.5	20*	< 24
RO-07-NIPNE	May 31	3.0	17	5	11	14.5	~ 48

EGI migration campaign

- GGUS ticket “DPM migration and decommission”
  - started on 09/09/2022 by EGI ops team
  - all DPM sites registered in EGI GOCDB (55 +2 suspended no ticket)
    - 2 already migrated (decommissioning old DPM)
    - 32 in progress
    - 16 on hold
    - 5 no reply from site
  - most of the sites – migrate before summer 2023 (or decommision SE)
    - several sites already trying dCache migration with their testbeds
    - higher fraction of EOS adopters with bigger SE, UK → CEPH+xroot
- Dynafed
  - never really used at scale, usually just R&Ds, web frontend for S3
  - rely on dmlite software stack which is part of DPM
  - same end of support timeline – summer 2024
  - XRootD S3 Gateway may become alternative for S3 backend

Summary

- The support level for DPM is going down
  - CERN provides (very limited) support till the summer 2024
  - EGI started ***DPM migration GGUS campaign*** in September 2022
    - ~ 60 DPM sites with ~ 100PB
    - migrate before June 2023 (end of EGI support)
      - migration tools part of latest EPEL (UMD) DPM/dmlite release
      - several prod. sites moved and use dCache successfully for 6+ months
      - sufficient to follow documentation
    - ***with a day of downtime your storage can start to use well supported software with much more features***
- Proper software support requires an effort
  - painful experience with poorly maintained “legacy” software
  - we should improve our software lifecycle management
    - define clear EOL if people lost interest in maintenance
    - provide migration strategy to modern and well supported alternatives

BACKUP

First site – prague_cesnet_lcg2

- Took some time to find right window for downtime
- Done by my colleagues to validate documentation
  - significant communication and related improvements
  - few migration steps too complicated → migration code improvements
    - set right spacetoken size from beginning
    - avoid WriteToken updates after migration (writetag & pushtag)
      - “complicated”, slow and error prone
        - necessary to run in right order (lost almost a day during migration)
      - dCache don’t provide tool to migrate existing files between spacetoken without copying data (implemented in **`migrate.py`**)
- After successful migration we were not able to read files with checksum validation
  - DPM can calculate missing checkum on demand
  - dCache checksum must be calculated / stored during file upload
- Missing functionality that correctly associate files with spacetoken

Taiwan DPM migration

- Successfully migrated their BelleII DPM at the beginning of May
  - just followed documentations
  - no support support from our side
- Issues with CMS instance migration
  - DPM was never fully converted in the DOME mode
  - still relied on legacy DPM stack with SRM protocol
  - no quotatokens defined for stored VO data files
  - migration tools ignored files without spacetoken
    - warning logged during migration
    - only directory structure imported in dCache namespace
    - Workaround using **`config.csv`** path attributes overwrite functionality
  - recent dmlite comes with more robust migrate.py
    - import immediately fails with no spacetoken defined
    - valid spacetoken assigned to the files with missing spacetoken
      - directory structure and spacetoken size

“big DPM” migration – praguelcg2

- So far biggest storage migrated to dCache with ~ 5PB & 50M objs.
- DPM consistency updates took quite some time
  - a lot of issues found, always using most recent dmlite
    - files stored in a wrong DPM pool moved – 1M files / 60TB / 2 days
  - one of supported VO did not use checksums – 10M files / 0.5PB / 2 weeks
- Extensive testing of migration tools
  - export / import validation
  - performance
    - export ~ 50GB MariaDB → 20GB namespace dump (SSD, 2.5hours)
      - export on DB node 2x faster than remote export from headnode
    - imported PostgreSQL size ~ 50GB
      - import from HDD only 2x slower than import from NVMe/SSD
      - import 2x faster on Intel i7-8700K compared to Intel Xeon E5-2630 v4
- Tuning default 100 movers limit per dCache pool (low for ATLAS)

RO-07-NIPNE migration

- Found two minor issues but with no impact on migration downtime
  - lost and dark data consistency updates stuck
  - lost database connection during DPM **`config.csv`** export
    - fortunately discovered by during test export
- Fixed in latest EPEL dmlite release
- Very slow DPM export
  - MySQL database on physical good hw but with spinning disks
  - order of magnitude slower export compared to praguelcg2 site
- Confirmed that HDD have negligible impact on PostgreSQL dCache namespace import performance
- Problems with periodic dCache service restarts
  - big 1PB diskserver caused OutOfMemoryError with default 4GB limit
    - dCache use “excessive” amount of memory to cache metadata
  - details in “troubleshooting section” of the migration documentation

Config – user / group maps

- DPM automatically create identity based on VOMS X509 proxy
  - dpm_user → certificate subject, dpm_group → VOMS FQAN
  - some user / group can be merged during migration
  - DPM users / groups without files not in the DPM topology export
- User mapping in DPM export
  - format: 'user',DN[,dcache_user[,dcache_uid]]
  - automatically / manually add dcache_user, dcache_uid
  - remove user line from mapping => use default user for given VO

~ 100 unique DNs
~ 30 unique FQAN
at prague DPM

- Group mapping in DPM export
  - format: 'user',FQAN[,dcache_group[,dcache_gid]]
  - automatically / manually add dcache_group, dcache_gid

overwrite dump with 'path',user,group,mode configuration for all subdirectories

- Generate corresponding gplazma2 and vogroup & multimap files
  - primary group from first FQAN + all other mapped FQAN groups
  - specific mapped username + uid or default VO username (group2uid)

Config – modifying permissions

- VO usually don’t need permission granularity for individual users
- dCache user / group mapping must be pre-configured
  - complicated to get info about all users in VO
  - special permissions to access VO user data with X.509 details
- For most VO it’s possible to avoid individual user mapping
  - use generic user that match VO group
  - remove all users from migration config file
- DPM permission model not same as dCache
  - optionally it is possible to overwrite permission during migration
  - cleanup owners, groups, ACLs currently used in DPM
    - format: path,directory,username,groupname,mode,ace_list,spacetoken
    - configuration applied recursively for subdirectories
      - original value used for empty arguments, e.g. path,/dir/,atlas,,,,
    - examples for ATLAS, BELLE, CMS in the documentation

Config migration – space

- Limit dCache available space per-VO / spacetoken
  - allow files to be distributed to all disknodes
  - aggregated performance
- dCache use storage pools, pool groups, links, link group
  - everything automatically generated during namespace import
  - configuration files must be distributed to headnode & disknodes
    - commented with info where to store them
  - dCache admin shell script
    - to create all pool groups, links and link groups
    - define spacetokens
- Directory layout different for dCache
  - migration script executed on disknode create hardlinks to dCache dir
  - also used to cleanup files from origiginal DPM directories
  - should be robust enough to deal with special characters (e.g. ‘\n’)

Steps to get working dCache
0) stop DPM
1) execute DPM export script
2) execute dCache import script
3) distribute dCache config files
4) run commands in admin shell
5) link existing files
6) start dCache

Additional steps

- Some configurations not enabled by default
  - commented out in generated dCache config files
  - described in documentation and briefly directly in config files
  - requires site specific data not available in DPM database
  - particular dCache service may not start with wrong configuration
- Argus
  - local argus server has to be specified before enabling in gPlazma
- StAR EGI accounting
  - configure which data to publish
- WLCG SRR
  - different URL after migration
  - needs to be communicated with VO that rely on SRR
- Telemetry
  - site specific details