CERN

CERN Tape Archive: production status, migration from CASTOR and new features

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What is CTA?

CTA service, integration with EOS and FTS

New features to the software stack

Migration from CASTOR to CTA

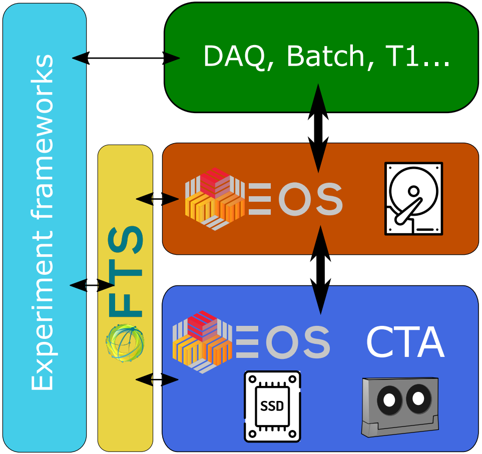
Future functionality

Conclusions

What is CTA?

- The CERN Tape Archive (CTA) is a tape backend for EOS
  - EOS is the CERN developed disk system for physics data
- A central CTA is the tape backend for several EOSCTA instances
- EOS:
  - provides the user interface (XRootd)
  - holds the directory structure, files metadata
  - manages disk (HDD or SSD) buffers
  - handles garbage collection
- CTA:
  - manages transparently file residence on tape
  - transfers tape files to/from disk cache on request from EOS

Current deployment model (I)



HDD icon: https://commons.wikimedia.org/wiki/File:Hard-drive.svg
SSD icon: https://commons.wikimedia.org/wiki/File:Ssd.svg
Tape icon: https://commons.wikimedia.org/wiki/File:Tape_cinta_casette_backup.svg

- Analysis/DAQ goes through the disk based EOS instance
- EOSCTA instances are dedicated to tape archive
- One EOSCTA instance per experiment, with dedicated namespace and storage space
- CTA is a shared tape service providing tape storage to all EOSCTA instances
- The File Transfer Service (FTS) can manage stage-in and transfers between EOS and EOSCTA

Current deployment model (II)

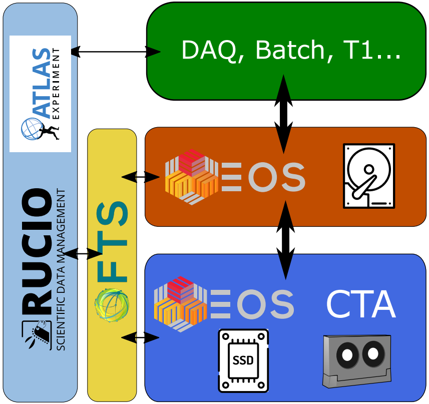
Plans for CERN T0 deployment

- Equipment in procurement
- Design validated in smaller scale pre-production
- 30 disk servers with ≈1 PB of SSD for buffering
- Tape servers transferred from CASTOR
    - Upgrade cycle coming soon

Integration with EOS and FTS

- All protocols and disk storage functionality available via EOS
- EOS has been extended to support tape related operations
  - Lifecycle management
  - Stage in
  - Cache/buffer management
  - Garbage collector
- More details in “EOS architectural evolution and strategic development directions”
- FTS support added for stage in in EOSCTA, transfer to EOS, eviction from buffer
- See also “FTS improvements for LHC Run-3 and beyond”

Integration with experiments: ATLAS



ATLAS EXPERIMENT

RUCIO SCIENTIFIC DATA MANAGEMENT

FTS

DAQ, Batch, T1...

EOS

EOS CTA

SSD

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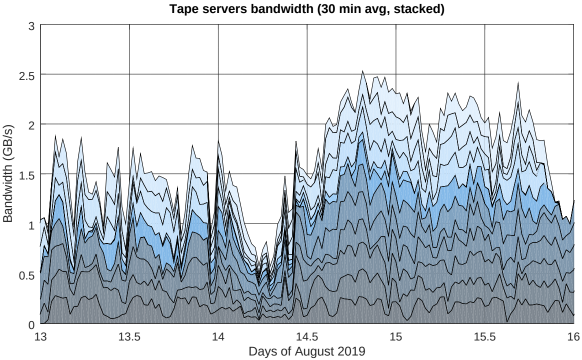
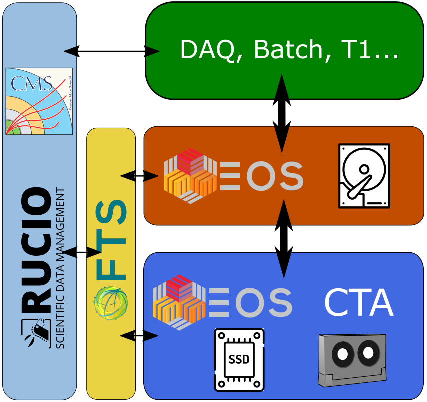
- Most advanced tests with an experiment
- Integration of Rucio
- Data taking: reached hardware saturation (April 2019)
- Data recall: Participated in 2018 reprocessing campaign (August 2019)
- See "The ATLAS Data Carousel Project"

ATLAS 2018 reprocessing campaign (Aug. 2019)



- Opportunity to replace a T1 with small scale EOSCTA instance
- Read-only EOS-CTA instance with imported CASTOR data for ALICE
  - Metadata imported from CASTOR
  - Actual tapes “borrowed” from CASTOR
- Limited number of SSDs (24 × 1 TB)
- 4 disk servers
- ATLAS’ Rucio used FTS to handle EOSCTA to EOS transfers
- Reached network limit for this deployment (2.5 GB/s)

Integration with experiments: CMS



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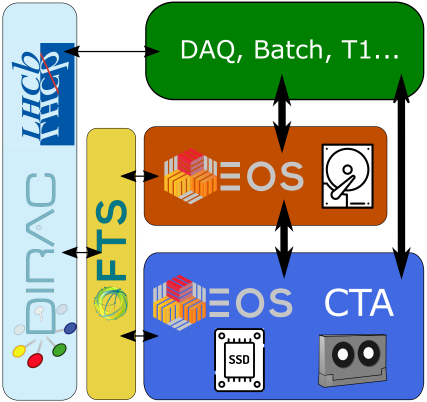
- Integration less advanced but expected to be similar to the one of ATLAS with CMS adopting Rucio

Integration with experiments: LHCb



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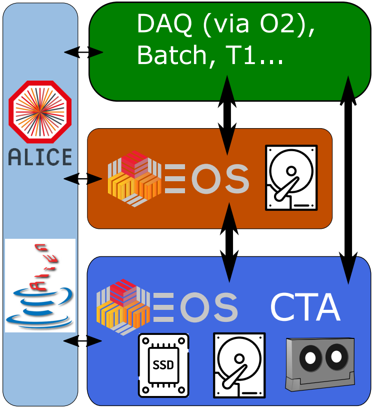
- Integration less advanced but expected to be similar to the one of ATLAS, with Dirac
- Direct T1 export for a small fraction of cases

Integration with experiments: ALICE



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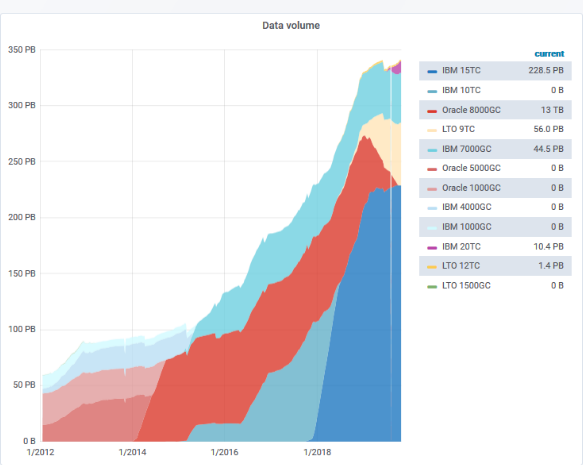
- Different use case
- SSD buffer for data intake
- Garbage collected ≈5 PB HDD cache for retrieves
- Occasional T1 access to EOSCTA



		current
🟦	IBM 15TC	228.5 PB
🟦	IBM 10TC	0 B
🟥	Oracle 8000GC	13 TB
🟧	LTO 9TC	56.0 PB
🟦	IBM 7000GC	44.5 PB
🟥	Oracle 5000GC	0 B
🟥	Oracle 1000GC	0 B
🟦	IBM 4000GC	0 B
🟦	IBM 1000GC	0 B
🟪	IBM 20TC	10.4 PB
🟨	LTO 12TC	1.4 PB
🟩	LTO 1500GC	0 B

Latest development (I)

Repack

- Behind the scene operations for tape repair, free space reclaim, media migration...
- Completion of repack enables production operations

Requests queueing

- Queueing was further optimized to reach 250 Hz

Latest development (II)

Retrieve scheduling: Activities scheduling

- Following discussions with ATLAS
- Intra-VO scheduling (other experiments unaffected)
- Prevents high latency for small request during big retrieve campaign

Retrieve scheduling: FIFO scheduling

- Avoids starving small mounts forever in high activity periods
- Optional switch between per-size or pre-age scheduling for retrieve (in development)

Tape file catalogue

- 3 backends for production: Oracle, PostgreSQL, MySQL
  - Oracle used for migration and current production
  - Targeting future production on PostgreSQL (no schedule yet)
  - MySQL support contributed by IHEP (Chinese Academy of Science). Many thanks to them!
- All flavors validated (like all of CTA) in continuous integration tests
  - See “System testing CERN physics archival software using Docker and Kubernetes”

Migration from CASTOR to CTA

- Metadata-only migration: tape format unchanged
- Migration from a single CASTOR namespace to 5 EOSCTA instances
- Oracle to Oracle for CASTOR → CTA
- Injection tool for CASTOR → EOS
- Migration experiment by experiment
- Requires preparation and cleanup on CASTOR side
- Can be done as a read-only import (validated during ATLAS test)
- Typical time few hours

Future functionality

- Provide fast positioning on LTO
  - Software solution addressing lack of drive-provided recommended access order (RAO)
- Pre-emptive scheduling
- Study of dataset collocation (PhD student)
- Various operations related features (drive dedication...)

Conclusions

- EOSCTA core ready for production usage
- Promising tests validated the deployment model
- Delivered full tape performance on limited hardware
- Migrations of experiments at various stages, some requiring adaptation in the pipeline
- Focus in 2020 will be migration out of CASTOR for LHC experiments

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