Cherenkov Telescope Array (CTA) report

L. Arrabito
LUPM CNRS-IN2P3, France

2nd Virtual DIRAC User Workshop 9th – 10th May 2022

DIRAC for CTA

- DIRAC in use since > 10 years to manage CTA Monte Carlo simulations
  - Several massive productions in the design phase to optimize the CTA array configuration and layout
  - Support user-specific simulations
- Using almost all DIRAC functionalities
  - WMS, DMS, TS and Production System, etc.
  - CTADIRAC extension developed
- CTA operations will start around 2023
  - Plan to use DIRAC-WMS for real data processing and Monte Carlo simulations potentially coupled with Rucio

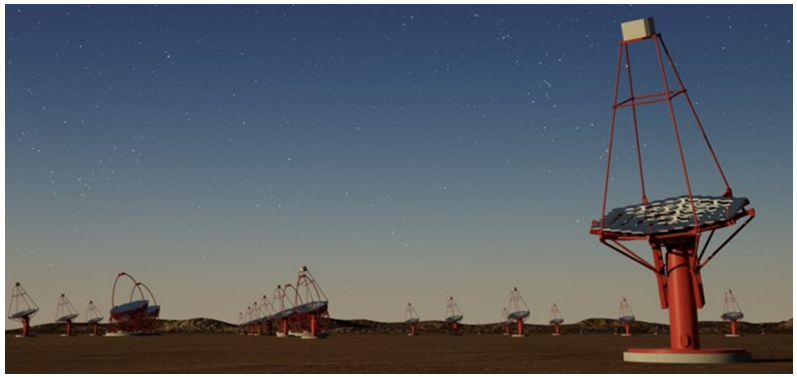
DIRAC for CTA

- Current installed DIRAC version : 7.3.12
- CTADIRAC server installation composed of 5 servers hosted at CC-IN2P3 and PIC
- Switched to python 3 in October 2021 for servers/client
- CTADIRAC extension also migrated to python 3
- Using resources available to the CTA VO
  - About 10 grid sites (HT-Condor, ARC)

CTA news : approved Array Layouts

CTAO-North, Canarian island

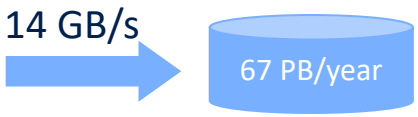
- 4 Large Size Telescopes
- 9 Mid Size Telescopes

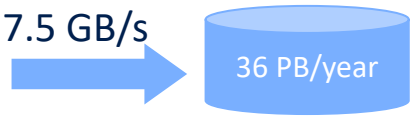


CTAO-South, Chile

- 14 Mid Size Telescopes
- 37 Small Size Telescopes

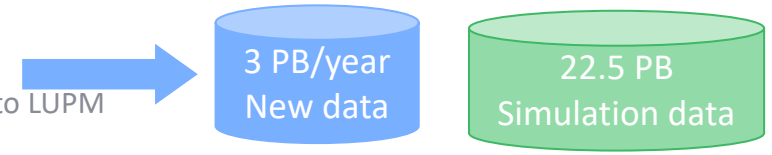
- 15% of observation time each year (dark time available per year)
- 20% monitoring and service data





1-2 Gbps capacity **-> Required Data Volume Reduction ratio after 5 years: 50**

TO BE TRANSFERRED OFF-SITE, PROCESSED, REPLICATED

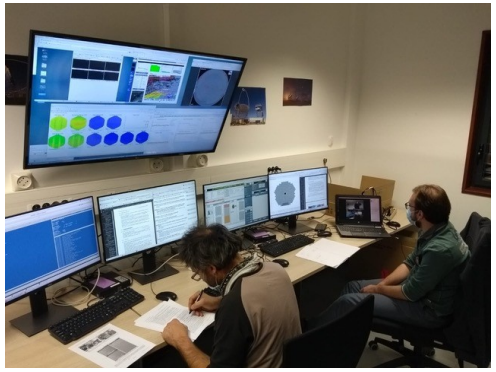


CTA news : retained Data Centres for off-site processing

4 Data centers ~ equally sharing processing load and storage

- PIC in Barcelona, Spain
- DESY in Zeuthen, Germany
- CSCS in Lugano, Switzerland
- INAF/INFN in Frascati, Italy

CTAO applications remotely controlled and monitored from the CTAO Science Data Management Center at DESY Zeuthen



DIRAC functionalities in use

- WMS
  - HTCondor and ARC CEs
  - Tests done in the past with SSH CE to access standalone clusters
  - Tests done with VMDIRAC to access Cloud resources (2017)
- DMS
- DIRAC File Catalog (Replica and Metadata Catalog)
  - More than 23 million replicas
  - About 20 meta-data defined to characterize CTA datasets
  - Using *datasets* to expose data selections to users and as input to transformations/productions (currently 650 defined datasets)
- Transformation System
  - For processing workflows and data management operations (FTS as backend)
  - Using the TSCatalog interface (CTA contribution)
- Production System (CTA contribution)
  - For processing workflows composed of several transformations
- Monitoring System with ElasticSearch backend
  - Component Monitoring/WMS history/RMS monitoring
  - Not able yet to use it for Job Parameters (open issue)

DIRAC functionalities we don't use

- Resource Status System
- Centralized Logging

-> Essentially for lack of time
but very interested to test and enable them soon

CTADIRAC extension 1/2

- Extensions of the DIRAC Job API to easily configure CTA applications
- Several scripts to configure/submit different CTA workflows
  - Create transformations for different kinds of CTA Jobs
  - Create productions to build more complex workflows
  - Using datasets as input for transformations and productions
- Scripts used within CTA jobs
  - e.g. put And Register files and set metadata
- Provenance Service to handle CTA provenance metadata
  - Included in CTADIRAC DMS
  - Using PostGreSQL DB as backend

-> Specific to CTA, cannot be ported to vanilla DIRAC

CTADIRAC extension 2/2

- Commands to manage transformations
  - e.g. Create a Moving transformation taking as input a dataset
  - Defined a procedure to finalize a Moving transformation (e.g. done at 97% and getting 'stuck') using a set of commands
    - Check the status of transformation requests, files, get replica informations
    - Take some actions for problematic files, stuck requests, etc. (unregister files, set files to processed, cancel requests, …)
    - Not sure that the procedure can be generalized to other kinds of transformations
- Commands to manage datasets (create, show, dump, get storage usage per SE, …)

-> All these can be generalized if interesting for others

What is your biggest frustration with DIRAC?

- No big frustration with DIRAC ☺
- Moving to python3, conda and installation with pip facilitates a lot the DIRAC installation (server/client and development setup)
- Topics we mentioned at the last workshop tackled since then
  - Tools to automatically install a fully operational DIRAC server instance (thanks for sharing puppet modules used at CERN)
  - Easy deployment and testing of a full DIRAC development instance

Additional desired features 1/2

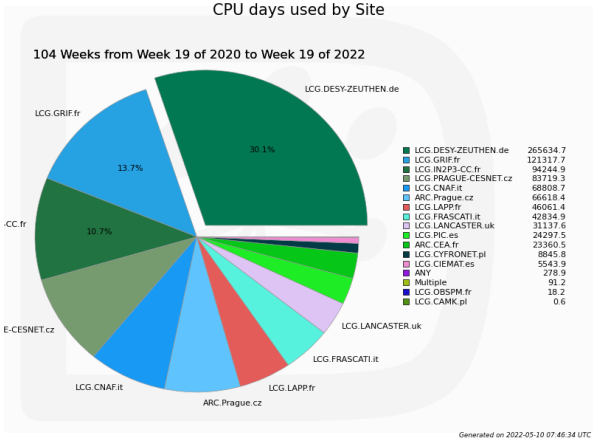
- Monitoring System
  - Installed since 2 years for : Component Monitoring/WMS History/RMS Monitoring
    - Component Monitoring is broken but will be restored in v8
  - Currently trying to enable Monitoring for Job Parameters
  - Interested in common Grafana/Kibana dashboards
    - Good to know that they will be available in v8

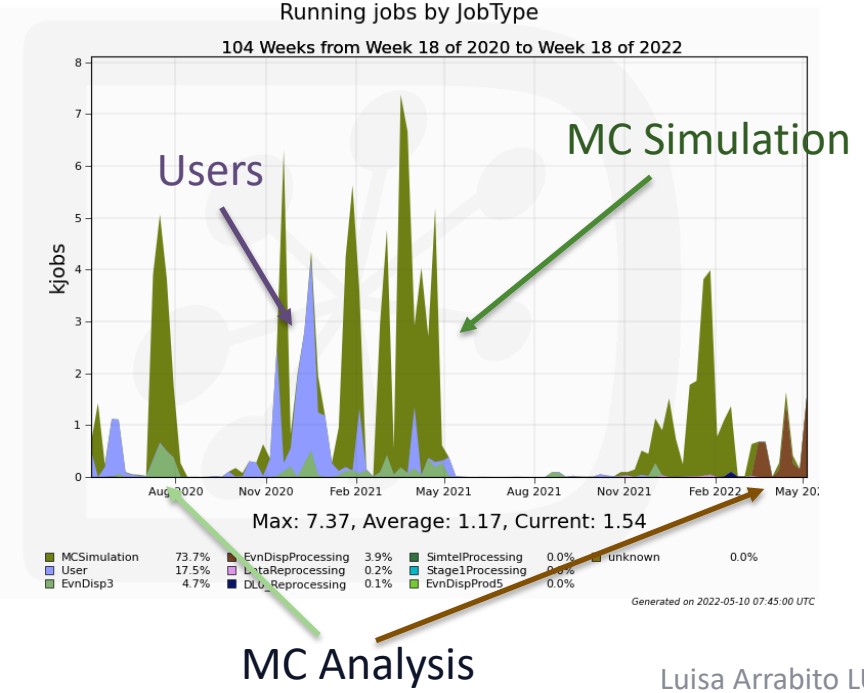
Additional desired features 2/2

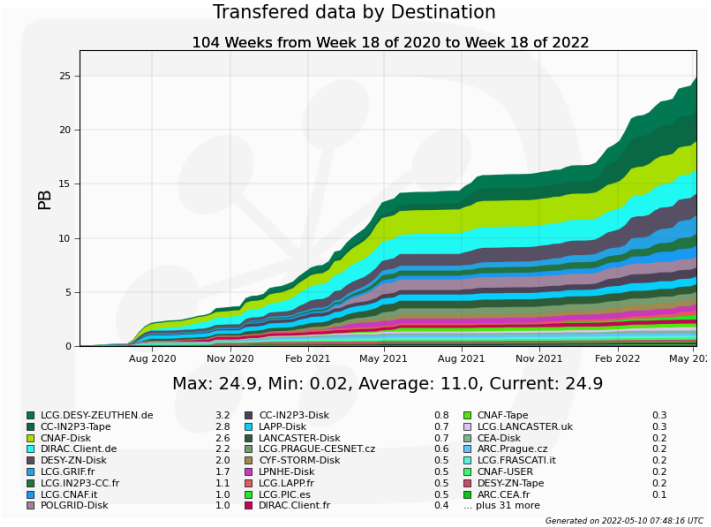
- Token-based AAI (e.g. with IAM)
  - Important for future CTA operations
  - Willing to test this feature when available in v8
- DIRAC-Rucio integration
  - Interested in a enriched interface, in particular for meta-data methods
  - Goal is to be able to use DIRAC Transformation System combined with Rucio

Operations with DIRAC in last 2 years

- About 285 millions CPU HS06 hours
- Used about 6 PB distributed in 7 SEs
- New members in the operation team (O. Gueta, F. Di Pierro)



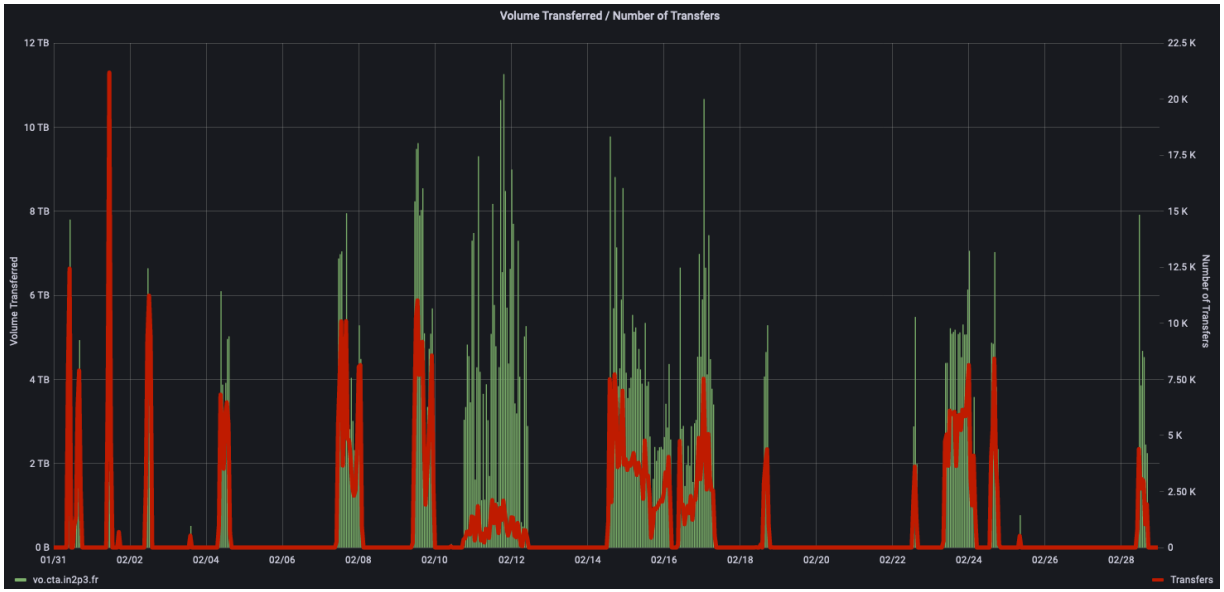




Data management operations in last 2 years

- Massive migration of ‘old’ productions from disk to tape (~3 PB)
- Removal of outdated productions (0.5–1 PB)
- Using Transformation System and FTS

FTS transfers in February 2022

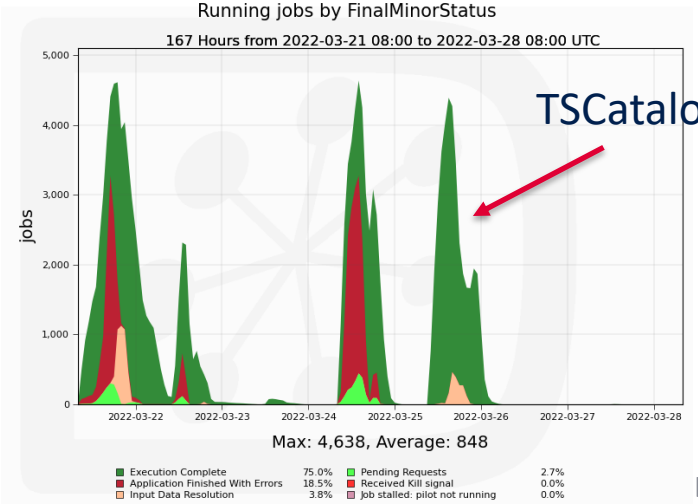


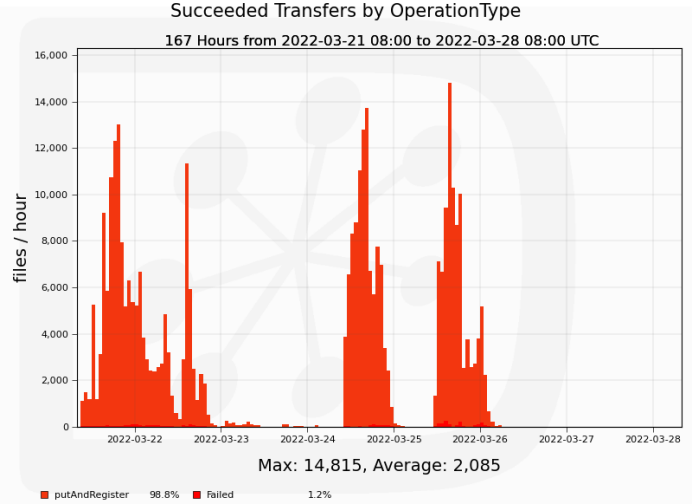
Operational incident in the last year 1/2

- Frequent connection timeouts to the Transformation Manager service during productions if using the TSCatalog

dirac-jobexec WARN: Issue getting socket: <DIRAC.Core.DISET.private.Transports.M2SSLTransport.SSLTransport object at 0x2b0b575a98b0> : ('dips', 'ccdcta-server04.in2p3.fr', 9131, 'Transformation/TransformationManager') : timed out:SSLTimeoutError('timed out')

- With TSCatalog enabled
  - Each file is registered in DFC is also attempted to be registered in the TSCatalog (addFile)
  - Idem for setMetadata





Operational incident in the last year 2/2

- Investigations done with DB and sys admins at CC-IN2P3
  - No particular CPU of I/O load observed on Maria DB cluster but found errors reading communication packets
  - No load observed on the server running the TSManager service
  - Relaxing some connection timeout parameters on the Maria DB server did not help
- The same problem reported also by Xiaomei for transformations with > 200k input files even without using the TSCatalog
  - https://github.com/DIRACGrid/DIRAC/discussions/6044
  - Currently trying to tune network parameters on the DIRAC server

Other news since last workshop

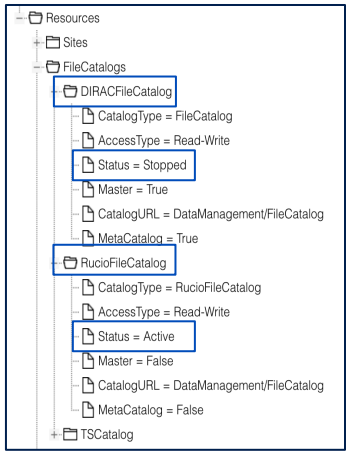
- Improved DB infrastructure for CTA-DIRAC at CC-IN2P3
  - 1 MariaDB Galera cluster (2 servers) hosting FileCatalogDB, TS DB, PS DB, RMS DB (other DBs hosted at PIC)
  - 1 standalone MariaDB instance hosting AccountingDB
  - No more DB incidents since this update
- Upgrade CTA-DIRAC servers
  - Replacement of 2 servers at PIC planned soon
- Started to use Grafana/Kibana dashboards for Monitoring
- CTADIRAC-Rucio integration (ESCAPE project)

CTADIRAC-Rucio integration 1/2

- Work done in the context of ESCAPE (F. Gillardo (LAPP), A. Bruzzese (PIC) and with the help of C. Serfon)
- Use case
  - Reprocess all raw data (DL0) to higher (DL3) level
- Simplified workflow
  - Raw (DL0) data is identified on tape via metadata
  - Data volume is calculated
  - Data is staged from tape storage to temporary disk
  - Data is reprocessed using CTA software via DIRAC-WMS
  - Final data products (DL3) are verified
  - Ingest the resulting new DL3 data into the datalake
  - Update the corresponding metadata

CTADIRAC-Rucio integration 2/2

- Using a Rucio instance dedicated to CTA managed by PIC
- Using the CTA-DIRAC certification instance
  - Single-server installation (VM hosted at CC-IN2P3)
  - Configured to use the RucioFileCatalog only (for simplicity)
- Using the RucioFileCatalog plugin available in v7.3.12
- Using belle2 extract scope algorithm for now
- First simple tests successful
  - Put and Register File using DataManager with RucioFileCatalog
  - Run jobs accessing Input Data registered in Rucio
- Interested to move to the 'no-config' Rucio version and DIRAC scope algorithm I learned about yesterday or implement a new one for CTA
- Further testing DIRAC-Rucio integration especially combined with the TS when metadata methods will be available



Conclusions and future plans

- DIRAC used successfully in the last ten years for CTA
  - Will play a central in future CTA operations
- Start moving towards a Computing Model with 4 official Data Centers to be used in CTA operations
  - Integrate new sites in CTADIRAC
  - Perform technical data challenges
- Future plans
  - Develop tools and procedures to achieve fully automatized data-processing
    - Full failure recovery for transformations/productions
  - Improve the Production System interface and **prepare a tutorial**
- New team member at LUPM from 1st April 2022
- New 2-years position will open at LUPM (end 2022 - start 2023)
- Very good communication and support from DIRAC dev team and other communities