Archive Prototypes in the Cherenkov Telescope Array: INAF Contributions

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How much BIG are DATA?

Without data compression and assuming 165 operational nights/yr:

**ASTRI/Prot.** → ~0.8 TB/night → ~0.3 PB/year

**Mini-Array** → ~3 TB/night → ~6.1 TB/night A.R. → ~1.0 PB/year A.R.

... and for CTA?

A pessimistic scenario can involve more than 100PB/year!

→ triggering systems?

→ data reduction on site?

or...

→ challenging with big data

**Once (period 2012-2016) the Archive’s principal requirement was:**

CTA Archive system must store, manage, preserve and provide easy access to such huge amount of data for a long time.
New Worlds, New Horizons in Astronomy and Astrophysics

Committee for a Decadal Survey of Astronomy and Astrophysics; National Research Council
This free PDF was downloaded from: http://www.nap.edu/catalog/12951.html

Data Archives

Data archives are central to astronomy today, and their importance continues to grow. The science impact of these archives is large and increasing rapidly. Papers based on archival data from the Hubble Space Telescope now outnumber those based on new observations in any year and include some of the highest-impact science from the HST, as shown in Figures 5.6 and 5.7. Data from the 2 Micron All
Archive is not a...

...simple “repository”!!!
Archive role is “central” for...

...an Astronomical Observatory

In the scientific data lifecycle of any OBSERVATORY the role of the Archive is central.

The major aim of a Scientific Archive is to guarantee data preservation and access information for the Long Term and for all data science products.

The archived information must be also usable by different user categories (data consumers) who are separate in time, space and background from the data producers.

Archive MUST be accessible well beyond the end of the operational life of the observatory.
Data Producers and Data Consumers are rigidly separated by the Archive System.
Prototyping CTA Archive

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CTA Collaboration & Community participated to the INDIGO-Data Cloud H2020 Project as "Use Case" for the INDIGO infrastructure.

The aim of our commitment was the very fruitful multi-disciplinary collaboration with INDIGO Communities in order to include the BigData challenges coming from the CTA Archive as an INTERNAL INDIGO Use Case / Case Study to be investigated with a distributed approach.

BIG-DATA Archive still needed?

In the Distributed Federation of Storage, OneDATA solutions are ready for CTA A&A.

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Few Snapshots from CTA workspace DISTRIBUTED ARCHIVE Prototype → Onedata's REST API's as well as oneclient command line tool for mounting virtual Onedata filesystem on the local machine.
Currently working the **Archive Prototype Solution** using:

- → the **ASTRI camera real data**
- → the **INAF-PRIN ASTRI CTA Data Challenge (AC-DC)** for mini-array based simulation
- → the **CHEC-M Camera real data**

since in last weeks CHEC-M Camera was hosted to the ASTRI prototype design and The ASTRI Archive is going to manage and store CHEC real data. Three CTA SST: GATE (left), ASTRI (centre), SST-1M (right).
Using the end-to-end ASTRI Archive System as data feeder

Prototyping CTA Archive

ASTRI Data Life Cycle

- collect info
- store data
- analyze data
- data mining & discovering
- higher levels
- preserve
- science community feedback
- publications

Plan
Integrate
Execute

T.A.C. evaluation
Proposal preparation
P.I. Science Goal

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Prototyping CTA Archive

CTA clients & End Users able to access to the CTA federated storage cloud through One Data interfaces (clients) + Users A&A.

OneClient: a command-line based application for accessing and managing user spaces (mounted in local FS) via virtual file system.
Prototyping CTA Archive

Archive Prototype testbed

- Access Catalogs, Multimission Archive, VOtools and MWC Science tools @SSDC node

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Archive Prototype testbed

- Access LHC-infrastructure (~10Gb connection) on DATA GRID using DIRAC for Simulations and Pipeline runtime @LNF (Frascati) node.

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REPOSITORIES (physical & logical)

DATABASES (mySQL & mongo) + couch-base

ASTRI Archive System

File name convention

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Physical & Logical Archives

SYSTEM Archive
- ASTR\_physical\_FS/
  - ORIGIN\_ID
  - DATE\_OBSEINIGHT
  - DATA\_LEVEL
  - TEL\_ID

PIPILEINE User
- ASTR\_logical\_PIPE/
  - ORIGIN\_ID
  - DL0
  - DL1
  - ... (LOGICAL FILENAME)
  - RAW
  - FITS
  - PROGRAM\_ID
  - OBS\_ID
  - TEL\_ID

MC User
- ASTR\_logical\_MCU/
  - ORIGIN\_ID
  - DL0
  - DL1
  - ... (LOGICAL FILENAME)
  - SIM\_FILE
  - FITS
  - RELEASE\_ID
  - PARTICLE
  - TEL\_ID (0)
  - TEL\_ID (n)
  - SAMPLE\_ID (DL1:lab)

P.I. User
- ASTR\_logical\_PIU/
  - OBSERVING\_PERIOD
  - PROPOSAL\_ID
  - PROGRAM\_ID
  - TARG\#1
  - TARG\#2
  - ... (LOGICAL FILENAME)
  - OBS\_DATE
  - DATA\_TYPE

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Knowledge Discovery DBs

...testing databases technology using ASTRI data-model...

Voldemort, Oracle BDB
Cassandra, HBase
MongoDB, CouchDB
Neo4J, InfoGrid, InfiniteGraph
SciDB, VDB
MySQL, Postgree, Oracle
ASTRI Gateway

PROPOSALS
Program
RUN
Targets
T.A.C.
EVAL
Data
Download
Observing LOG

intro
register
help
USER
LOGIN
user
profile
Proposal
FORM
CoPI
Sched
RUN

Observing Scheduler

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ASTRI User Access #1

**QUERY & SELECT DATA**
(from lev0 to lev5 / photon list)

**RETRIEVE & SAVE ALL LEVEL DATASETS**

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ASTRI User Access #2

BROWSE, INSPECT DATA & SIMULATIONS (from lev0 to lev5)

EXTRACT META-DATA SETs

OneData Client: get a token to access to DATA SETs related to a custom query

Mount locally a VIRTUAL FS related to token auth

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ASTRI Hardware

- Switch T.O.R. 1 → 10Gb/s
- Other OneData nodes???
- OneData Provider#3 (@SSDC)
- OneData Provider#2 (@LNF)
- OneData Provider#1 (@OAR-MPC)
- Redundant ASTRI services
- ASTRI Gateway (gitLab & redmine)
- Mirror ASTRI Gateway
- Switch KVM
- Other Computing???
- DBs Service and File Catalogs & Pipeline (devel & Runtime)
- STORAGE (expanding ~1PB)
- Other Storage???
- UPS downstream and stabilized by the Institute’s UPS
CTA Observatory Archive Assumptions

→ 2 Data Production Sites
→ Low-Lev BigData Storage (“close” data-prod Sites?)
→ Data Compression & Reduction (on-site?)

CTA Cloud

- Coherent (big) Data Aggregated & Distributed in few different Sites
  => fast&high throughput LAN (i.e. LHC-One)
  => large computing and large storage
    (medium-size data centers: 1-2 full rack dedicated to CTA)
  → use-case “ready” for both the BULK (DPPS) Arch. and SCIENCE (SUSS) Arch.
  → On site only redundant RAW Storage ←

- All Dataset (small) Distributed in many EUROPEAN sites
  => providers must be connected (see C.A.P.)
  => medium computing and storage
    (small-size data centers: “half”-rack hosted in institutes’ CED)
  → use-case is “ready” for SCIENCE (SUSS) Arch.
  → BULK (DPPS) Arch. on-sites ←

ASTRI-miniArray environment is ready for both solutions
even centralized data centers on site (incremental archive)

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OneData system **virtualizes** storage systems provided by storage resource providers **distributed** globally.

The most important concepts of the platform are:

**Spaces** - distributed virtual volumes, where users can organize their data

**Providers** - entities who support spaces with actual storage resources

**Zones** - federations of providers which enable creation of closed or interconnected communities.
CTA OneZone

- **OneZone** is the gateway for users to the OneData system. It is responsible for connecting to the **authentication** and **authorization** infrastructure.

- It allows users to:
  - create **user spaces**
  - generate space **support tokens**, that can be used to support user spaces with storage from a dedicated storage provider
  - **monitor availability** of storage providers that support user spaces
  - see the **geographical distribution** of storage providers
  - choose **storage provider** for spaces
CTA OneProvider(s)

- **OneProvider** exposes storage resources. It is deployed in a data or computing center, on the nodes equipped with high speed connections to storage resources.
CTA OneProvider(s)
CTA OneClient

• **OneClient** is a command-line based application for accessing and managing user spaces via virtual file system.

• User spaces are **mounted** in the local file system tree (i.e. in a Grid Storage-Element FS as well).
Metadata

Metadata in OneData are organized into 3 levels:

✓ **Filesystem attributes** - basic metadata related to file system operations such as file size, creation and modification timestamps, POSIX access rights, etc.,

✓ **Extended attributes** - these attributes enable assigning custom key-value pairs.

✓ **User metadata** - this level provides most flexibility and OneData itself does not assume any schema related with these metadata. For each resource, user can assign a separate document in one of supported metadata formats (currently JSON and RDF).

The filesystem and extended level attributes are accessible via **REST-API** and **CDMI** or directly through queries to the embedded database.
## Metadata

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATATYPE</td>
<td>000</td>
</tr>
<tr>
<td>DATA_LEVEL</td>
<td>lv0</td>
</tr>
<tr>
<td>MODES_ID</td>
<td>R</td>
</tr>
<tr>
<td>OBSERV_ID</td>
<td>00001</td>
</tr>
<tr>
<td>ORIGIN_ID</td>
<td>41</td>
</tr>
<tr>
<td>Packet_Type</td>
<td>1002</td>
</tr>
<tr>
<td>Path</td>
<td>/CTADATASPACE/astri_000_41_001_00001_R_000004_000_1002.lv0</td>
</tr>
<tr>
<td>Program_ID</td>
<td>001</td>
</tr>
<tr>
<td>PROP_ID</td>
<td>0000000000000001</td>
</tr>
<tr>
<td>RUN_ID</td>
<td>00004</td>
</tr>
<tr>
<td>Sequence_num</td>
<td>000</td>
</tr>
<tr>
<td>TSTART</td>
<td>43058055</td>
</tr>
<tr>
<td>TSTOP</td>
<td>43058065</td>
</tr>
</tbody>
</table>

Save all changes  | Discard changes  | Remove metadata

File:
- `astri_000_41_001_00001_R_000004_000_1002.lv0`

Size: 916.88 KB
Modification: 2017-01-13 12:01

File:
- `astri_000_41_001_00001_R_000005_000_1002.lv0`

Size: 916.88 KB
Modification: 2017-01-16 11:01
function(meta)
{
  if(meta['PROGRAM_ID'])
  {
    return meta['PROGRAM_ID'];
  }
  return null;
}
References

- ASTRI web page: http://www.brera.inaf.it/astri/
- YouTube demo: https://youtu.be/UhOWNJluIgE
- INDIGO Data Cloud: https://www.indigo-datacloud.eu
- OneData documentation: https://onedata.org/docs/index.html
- OneData @ docker hub: https://hub.docker.com/u/onedata/
SSDC as server of CTA data products

• The ASI-SSDC (Space Science Data Center):
  – wide experience as MWL data center, both for low-level data products (AGILE data center, Fermi-LAT/SWIFT/... data mirror center) and high-level data, data products and catalogs.
  – Data and data products integrated in a fully MWL environment (MMIA: Multi-Mission Interactive Archive).
  – Possibility to perform cross-catalog searches between resident and external catalogs.
  – Powerful tools to extract SED of sources and modelization.
  – VHE catalog products from literature already integrated in the TeGeV Catalogue.