# Present and Future of Data E-Infrastructure to Support Computing in INAF

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# Where Should I Put My Data?

# Big Data

The term “big data” refers to data sets so large and complex that traditional tools, like relational databases, are unable to process them in an acceptable time frame or within a reasonable cost range. Problems occur in sourcing, moving, searching, storing, and analyzing the big data

The 3Vs of Big Data: Volume, Velocity, Variety

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# How Should I Prepare My Data?

# Storage and Archive

Data structure, consistency, cleanness, order, organization are key point to reach the goal of find useful information in millions or billions of digital objects.
Distinction between collections, organization of different sized datasets, timing of data usage are fundamental considerations to do before organizing the Big Data

# The FAIR Guiding Principles

To be Findable:

F1. (meta)data are assigned a globally unique and persistent identifier
F2. data are described with rich metadata
F3. metadata clearly and explicitly include the identifier of the data it describes
F4. (meta)data are registered or indexed in a searchable resource

To be Accessible:

A1. (meta)data are retrievable by their identifier using a standardized communications protocol
A1.1 the protocol is open, free, and universally implementable
A1.2 the protocol allows for an authentication and authorization procedure, where necessary
A2. metadata are accessible, even when the data are no longer available

To be Interoperable:

I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation
I2. (meta)data use vocabularies that follow FAIR principles
I3. (meta)data include qualified references to other (meta)data

To be Reusable:

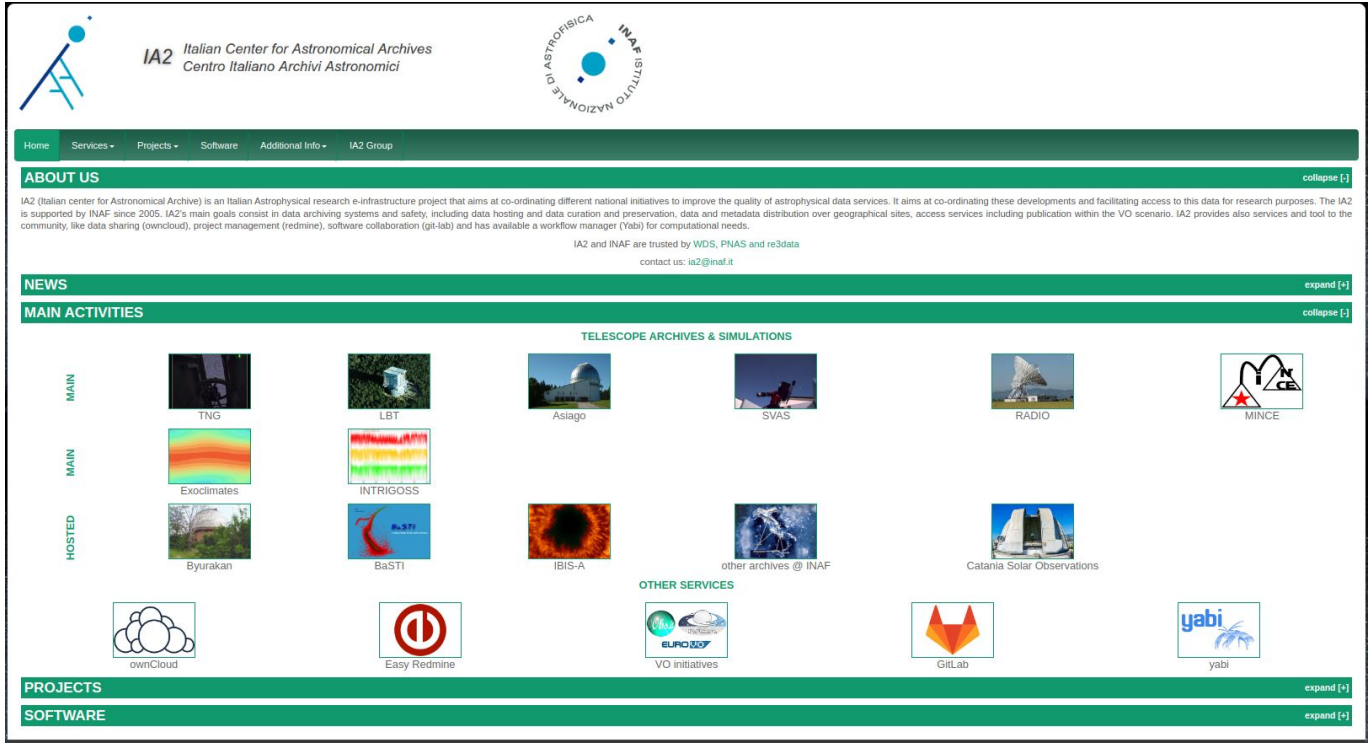
R1. meta(data) are richly described with a plurality of accurate and relevant attributes
R1.1. (meta)data are released with a clear and accessible data usage license
R1.2. (meta)data are associated with detailed provenance
R1.3. (meta)data meet domain-relevant community standards

# Data Management Plan

Some useful questions to create your Data Management Plan:

- What data will you collect or create?
- How will the data be collected or created?
- What metadata will describe the data?
- How will you manage access and security?
- How will you manage copyright or access policies?
- How will you manage any ethical or legal issues?
- How will the data be stored and backed up?
- Which data are of long-term value and should be preserved?
- How often your data will be accessed?
- Who are the end users or the reference community who will use this data?
- How will you share the data?
- Who will be responsible for data management?

# Centro Italiano Archivi Astronomici - IA2




https://www.ia2.inaf.it/

- Astronomical archives
- Data curation and preservation
- Storage
- Long term preservation
- Data publication in the VO
- Hosting and managing INAF ICT services
- Support to astronomical projects
- Services and tools (collaboration tools, workflow, etc.)

# IA2 Storage

Hot storage

Distributed Data-Centre

Sites: OATs, IRA Bo, OACa, OAPd - Asiago
Storages: 1.7 PB + 400 TB + 270 TB + 280 TB + 60 TB + 100 TB

Lustre: 500TB + 1.2PB on JBOD

# IA2 Tape Library

IBM TS4500 - 8 drives LTO-8

240 Cartridge of about 9TB each

Total: ~2PB (expandable up to 16PB)

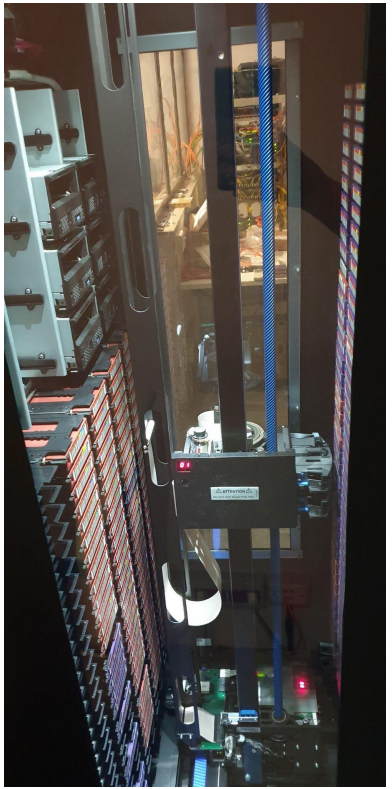
Data in Tape:

- 430 TB used (82 cartridge)
- 1600TB free (158 cartridge)

Free space is not real since we must check data before copying them on Tape

Front-End:

- Lenovo server 92 TB all flash
- 70 TB licensed IBM Spectrum Scale and Archive (GPFS)



Cold storage

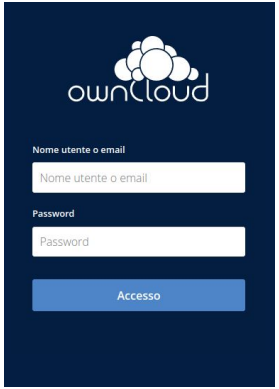
# IA2 Services: ownCloud and VOSpace

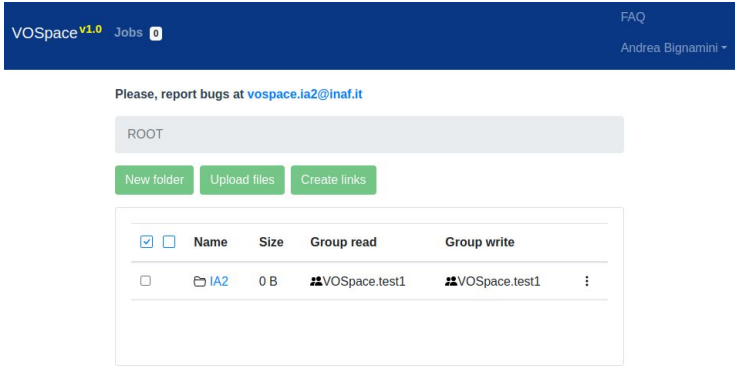
https://owncloud.ia2.inaf.it/

Available for all INAF users

No long term

10 GB quota per user




http://vospace.ia2.inaf.it/ui/

Hot and Cold storage

For Middle and Long term preservation

No quota

IVOA Reccomandation https://www.ivoa.net/documents/VOSpace/

# VOSpace Architecture

VOSpace consists of four services running on frontend and backend hosts

Backend mounts
- Hot storage -> Lustre
- Cold storage -> Tape FE

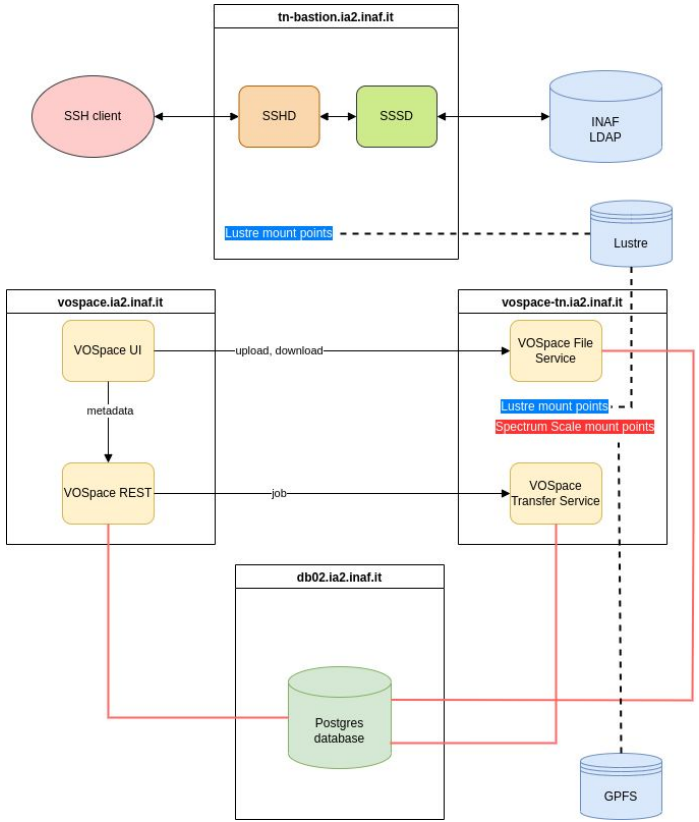
Postgres database keeps track of where data is stored

Upload from web interface limited to 10GB per file

Upload from web interface only to hot storage

The Transfer-Node is used to:

- upload huge amount of data
- upload data to Tape
- asynchronous download from Tape



# VOSpace: Data Upload to Tape

Data writing on Tape is supervised by IA2 Staff

User has to:

- Prepare data to put in Tape
- Compute checksums at data source with bash or python script provided by IA2
- Copy data from data source to Transfer-Node via ssh (INAF LDAP credentials)

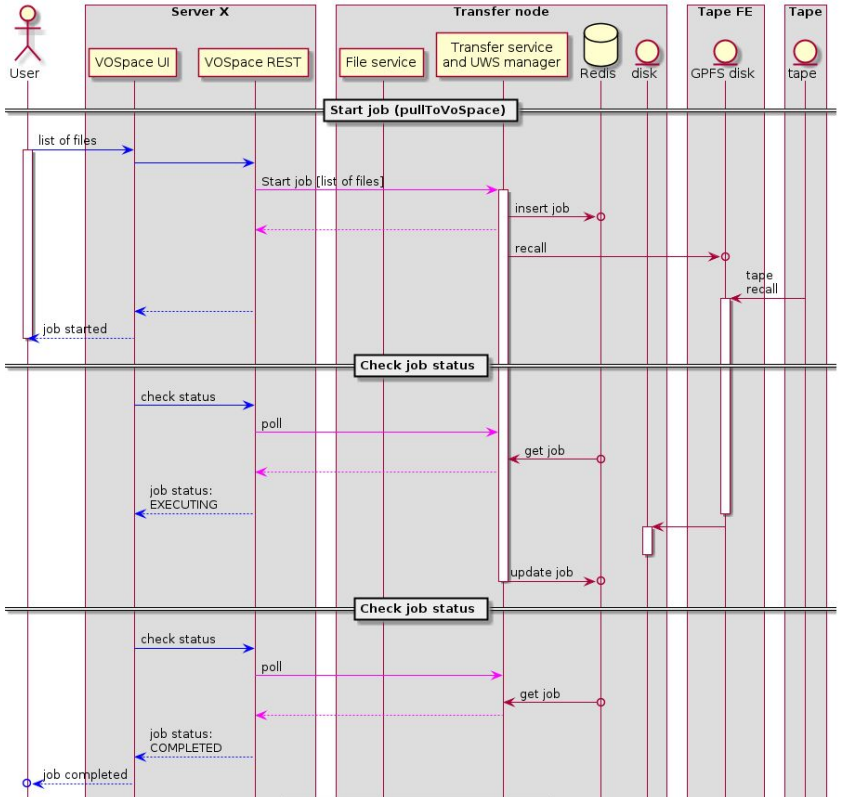
Then IA2 Staff has to:

- Compare checksums
- Check files (empty files, empty folders, too many files per folder, temp files, wrong or special characters in filenames, etc.)
- Create new home directory node on VOSpaces to allow user to access data in Tape
- Copy data from Transfer-Node to Tape (in chunks of 10-20 TB) through Tape Front-End
- Import data into VOSpace database

Data is now available in VOSpace

# Asynchronous Download from TAPE

- The user requests to download data through the VOSpace UI
- VOSpace UI sends a request to the VOSpace REST service
- The job is queued in the VOSpace Transfer service
- Tape FE recalls requested data
- Data are available in GPFS
- VOSpace Transfer service copy from GPFS to Lustre
- Data is now available for download using VOSpace UI or Transfer-Node (e.g. rsync over ssh)



# INAF Tier-3

**TIER-3 sized storage+computational system**

In the process of defining the call for tenders: Cineca – INAF joint action. System aimed at putting *storage and hardware associated* with it into operation for use in SKA-precursors, Pathfinders and relative development environments.

**STORAGE LONG TERM**: Tape Library with LTO tapes ≈ **6 PB** expandable up to 100 PB

- **Slow-medium speed STORAGE** on disks: ≈ **4-5 PB**
- **High speed STORAGE scratch** on disks: ≈ **2 PB**
- **Computational nodes**. *40 FAT nodes*: 2 CPU x86 (>= 48 cores) and 1TB RAM; *14 Accellerated nodes*: 2 CPU x 86 (>=48 cores) and 512 GB RAM, 2 CPU x node with 80 GB memory, CUDA compatible

# Future Perspectives

- Direct connection between the distributed storage (IA2 sites and Tier-3), and PLEIADI, CINECA and data sources
  - Direct connection through a physical hardware node, if storage and computational resources are physically close
  - VPN over GARR Network
    - A single VPN that includes PLEIADI (Bologna, Catania and Trieste) and IA2
    - Dedicated point-to-point virtual channels not intermediated by routers and firewalls, but still safe and secure
- Improve writing and reading from Tape
  - IBM Spectrum Archive upgrade to IBM Spectrum Protect: better performance, upgraded backup features and flexibility
  - Transfer-Node upgrade:
    - Dedicated server independent of Lustre storage
- Optimization of recall procedures from Tape
  - Proper organization of data collection according to data management plans
- Expand the storage
  - Expand the existing Tape
  - Add Tier-3 into the mix
- With two INAF Tape libraries available, implement redundancy and a real policy of disaster recovery!
- Improve services related with data preservation
  - Expand services offered to astronomical community in a VO compatible and interoperable way
- Increase IA2 expertise in the field of software infrastructure management systems

# How Should I Prepare My Data?
# Where Should I Put My Data?

Data Preparation and Data Curation are time consuming (and boring)

But they are mandatory if you do not want to put data in a long term storage and eventually lose them (remember the messy warehouse)

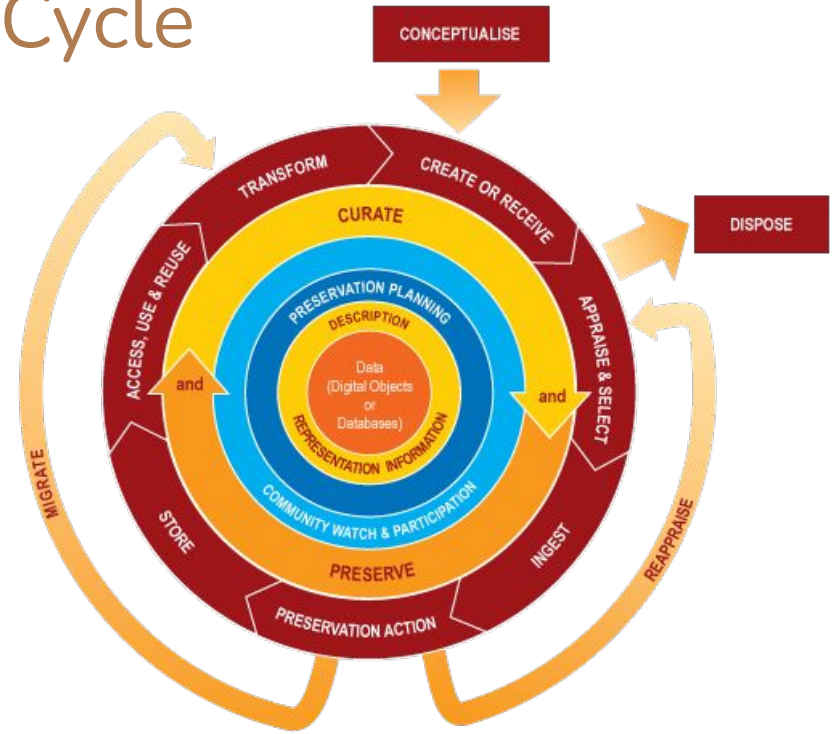
FAIR Principles and Data Life-Cycle are useful to build a proper Data Management Plan

Embrace and spread the FAIR culture

Adopt an Use Case driven approach

# Backup Slides

# Data Life Cycle




Ref: https://www.dcc.ac.uk/guidance/curation-lifecycle-model