



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

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INAF



Workshop INAF USC VIII - Calcolo Critico
Catania 15-16 June 2023



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:

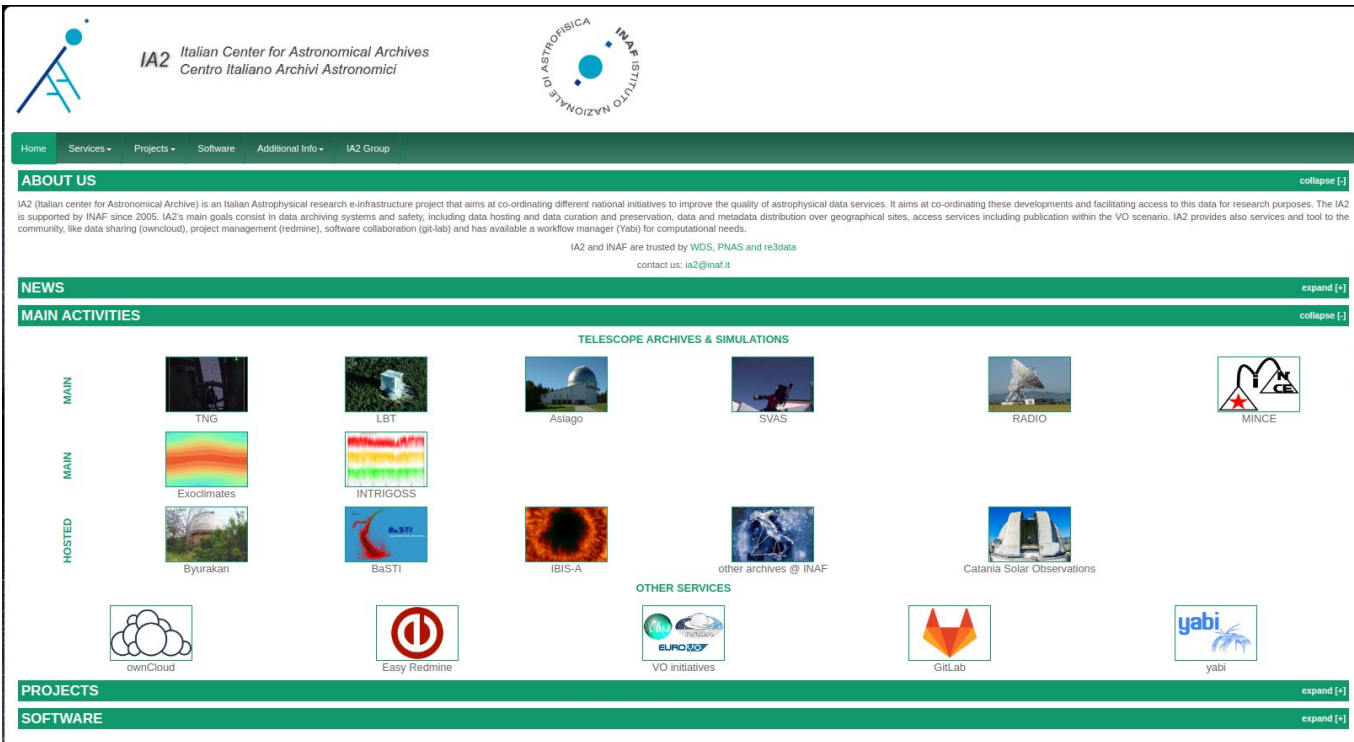
- R1. meta(data) are richly described with a plurality of accurate and relevant attributes
 - R1.1. (meta)data are released with a clear and accessible data usage license
 - R1.2. (meta)data are associated with detailed provenance
 - R1.3. (meta)data meet domain-relevant community standards

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



The screenshot shows the IA2 website homepage. At the top left is the IA2 logo, a stylized blue ladder with a dot at the top. To its right is the text "IA2 Italian Center for Astronomical Archives Centro Italiano Archivi Astronomici". Further right is the INAF logo, a circular emblem with "INAF ISTITUTO NAZIONALE DI ASTROFISICA" around the perimeter. Below the logos is a green navigation bar with links: Home, Services, Projects, Software, Additional Info, IA2 Group. The main content area has a green header "ABOUT US" with a "collapse [-]" link. The text below describes IA2 as an Italian Astrophysical research e-infrastructure project. Below this is a "NEWS" section with an "expand [+]" link. The "MAIN ACTIVITIES" section has a "collapse [-]" link and is divided into "TELESCOPE ARCHIVES & SIMULATIONS" and "OTHER SERVICES". Under "TELESCOPE ARCHIVES & SIMULATIONS", there are three columns of icons: "MAIN" (TNG, LBT, Asiago, SVAS, RADIO, MINCE), "MAIN" (Exoclimates, INTRIGOSS), and "HOSTED" (Byurakan, BaSTI, IBIS-A, other archives @ INAF, Catania Solar Observations). Under "OTHER SERVICES", there are icons for ownCloud, Easy Redmine, VO initiatives, GitLab, and yabi. At the bottom, there are "PROJECTS" and "SOFTWARE" sections, both with "expand [+]" links.

IA2 Italian Center for Astronomical Archives
Centro Italiano Archivi Astronomici

INAF ISTITUTO NAZIONALE DI ASTROFISICA

Home Services Projects Software Additional Info IA2 Group

ABOUT US collapse [-]

IA2 (Italian center for Astronomical Archive) is an Italian Astrophysical research e-infrastructure project that aims at co-ordinating different national initiatives to improve the quality of astrophysical data services. It aims at co-ordinating these developments and facilitating access to this data for research purposes. The IA2 is supported by INAF since 2005. IA2's main goals consist in data archiving systems and safety, including data hosting and preservation, data and metadata distribution over geographical sites, access services including publication within the VO scenario. IA2 provides also services and tool to the community, like data sharing (owncloud), project management (redmine), software collaboration (git-lab) and has available a workflow manager (Yabi) for computational needs.

IA2 and INAF are trusted by WDS, PNAS and re3data
contact us: ia2@inaf.it

NEWS expand [+]

MAIN ACTIVITIES collapse [-]

TELESCOPE ARCHIVES & SIMULATIONS

MAIN
TNG
LBT
Asiago
SVAS
RADIO
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OTHER SERVICES

ownCloud
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VO initiatives
GitLab
yabi

PROJECTS expand [+]

SOFTWARE expand [+]

<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)

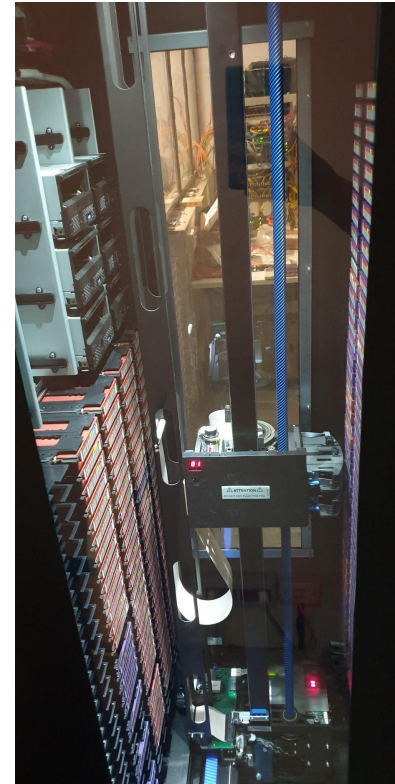
1600TB free (158 cartridge)

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

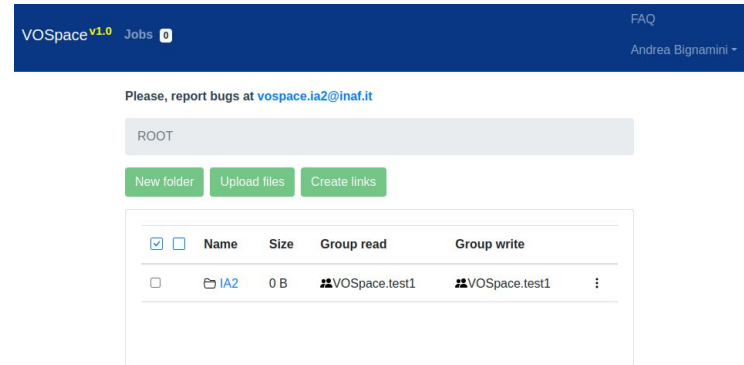
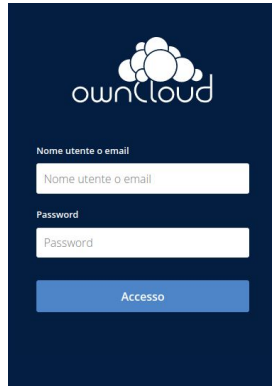
IA2 Services: ownCloud and VOSpace

<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 Recommendation <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

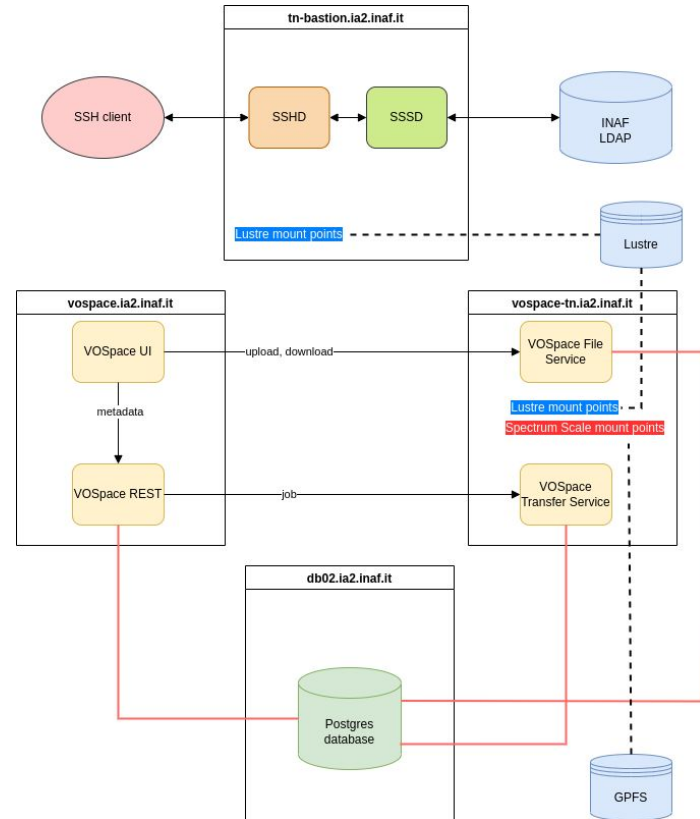
Postgres database keeps track of where data is stored

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)

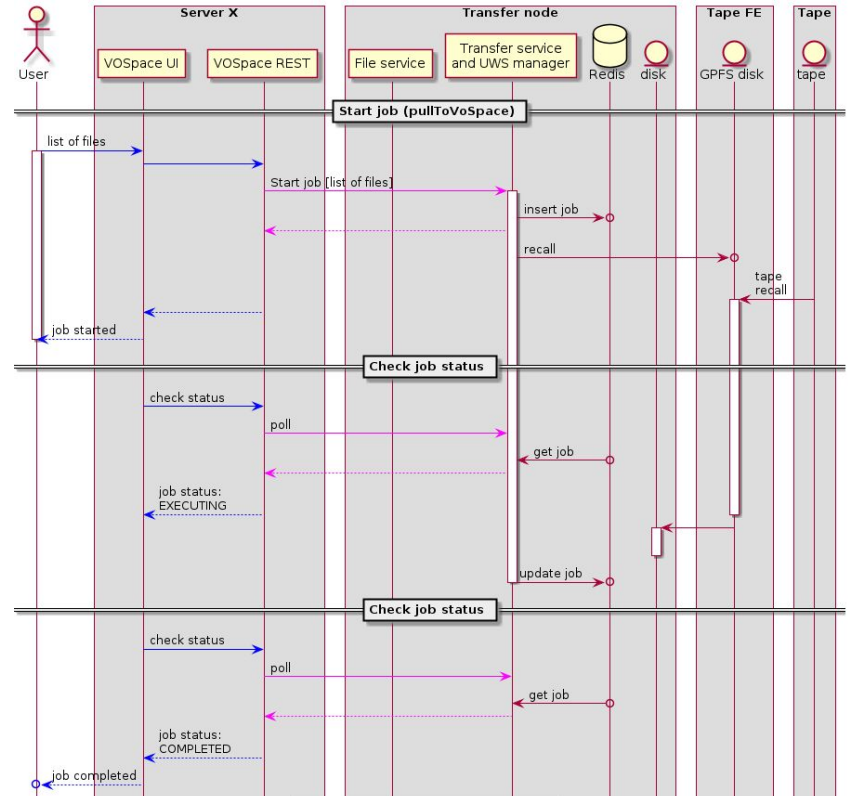
Then IA2 Staff has to:

- 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 \approx **6 PB** expandable up to 100 PB

- **Slow-medium speed STORAGE** on disks: \approx **4-5 PB**
- **High speed STORAGE scratch** on disks: \approx **2 PB**
- **Computational nodes.** 40 FAT nodes: 2 CPU x86 (\geq 48 cores) and 1TB RAM; 14 Accelerated nodes: 2 CPU x 86 (\geq 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

