

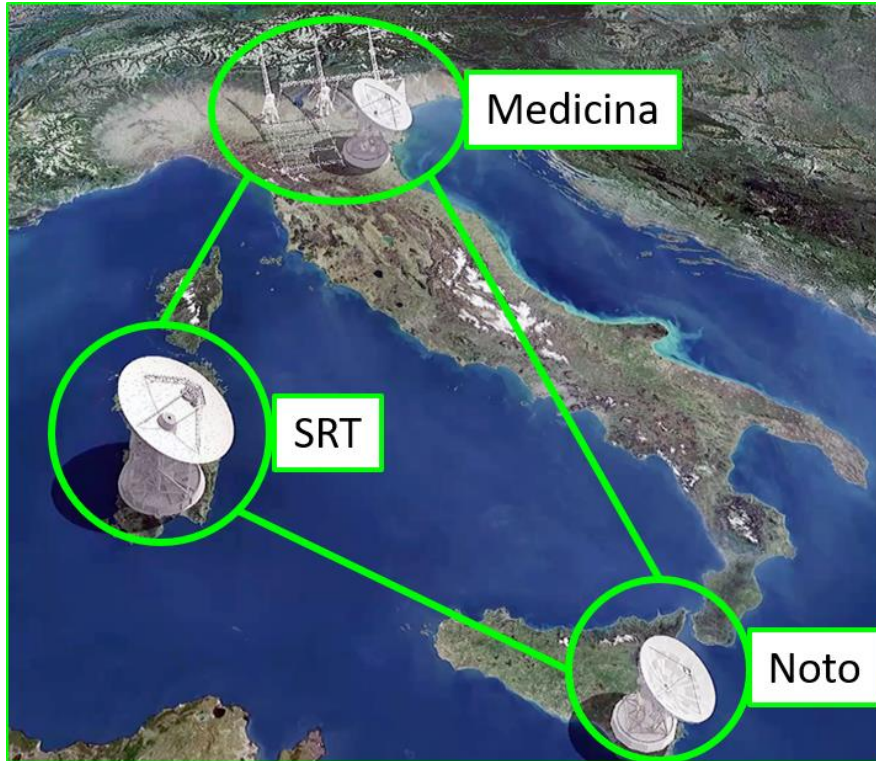
The INAF radio data archive: towards FAIR data handling

A Zanichelli - INAF IRA



From Science Gateways to Papers - May 24th, 2022

The INAF radio telescopes



Observing modes:

SD



Pulsar

VLBI

Share the same control software
and data format

In operation: 300 MHz – 26(+) GHz
Total intensity, spectropolarimetry

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Observing with the Italian radio telescopes

Welcome to the Italian radio telescopes users' page
Here you can access all of the resources needed to achieve successful single-dish and extra-EVN interferometric observations

[Contact us](#)

*Regular call is closed. The next deadline will be in October 2022.
Proposals for ToOs and DDT can be submitted anytime.
The offered instrumentation is [listed here](#).*



Pre- and post-observation COMMON TOOLS

Proposals How to submit your proposal in order to request observing time. GO	Planning Estimate the observing time you need and check the visibility of sources. GO	Schedules Learn how to prepare the observing schedules using our writer. GO	Calendars Allocated antenna time at the three observatories. GO
Ticketing Submit a ticket to inform us about problems and inefficiencies. ComingSoon	Post-obs feedback Let us know whether your observing session met your goals. GO	Data archive Retrieve your data and find details on their format. GO	Reduction tools Discover and download the available data reduction tools. ComingSoon

Observing with the SRT

SRT user's guide Online user's guide to the SRT control system. GO	Technical details SRT info, describing the available hardware. GO	Webcam Webcam showing the 64-m dish. GO	Weather monitor Check SRT's weather station online monitors. GO
Science with the SRT Read about the Early Science projects carried out with the SRT. GO	Information for observers Logistics and other useful information for observers. GO		

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<https://www.radiotelesopes.inaf.it>

The INAF radio archive Working Group

INAF IRA

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Massimo Sponza

INAF OAC

Marta Burgay

Raimondo Concu

Antonietta Fara

Sergio Poppi

Andrea Possenti

WARNING!
Only raw
data, at the
moment

<http://radioarchive.inaf.it>

radioarchive.inaf.it

67%

Search

Help

hA Your files Login

Simple search VLBIIT search SD search Pulsar search

File name

Name resolver: Object name Resolve

☐ RA (J2000) hh:mm:ss.ss ☐ Dec (J2000) dd:mm:ss.ss Radius (arcmin) 14

☐ Toggle all

☐ Equinox Select...

☒ Obs date From: yyyy-MM-dd To: yyyy-MM-dd

☒ Frequency [MHz] From: To:

☐ Project id

☐ Telescope Select...

☐ Frontend Select...

☐ Bandwidth [MHz] From: To:

☐ Exposure time [s] From: To:

☐ LST From: hh:mm:ss.sss To: hh:mm:ss.sss

☐ Scan type Select...

☐ Spectral resolution [MHz]

☐ Frequency bins

☐ Wobbler Select...

☐ Creator

☐ Format version

☐ Backend Select...

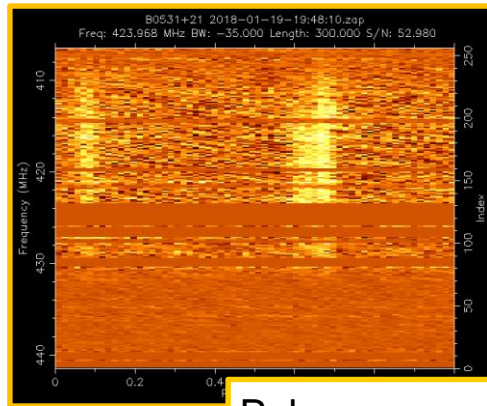
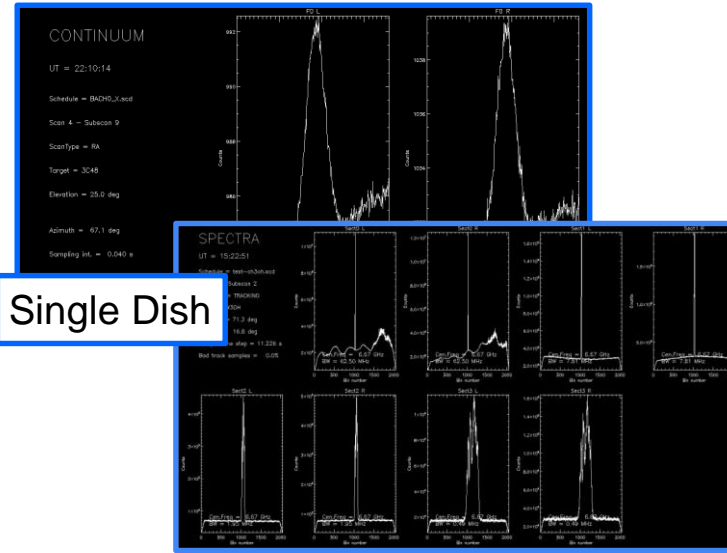
☐ Rest frequency [MHz]

Search Reset

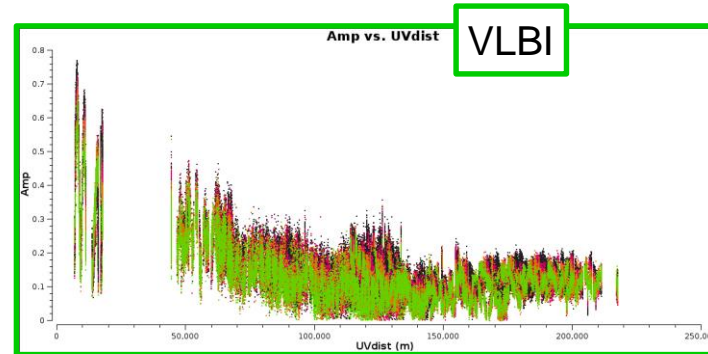
Progressively
being
populated
with SD,
pulsar and
VLBI-IT data
(VLBI-IT =
software
correlated in
Bologna)

Variety of data types

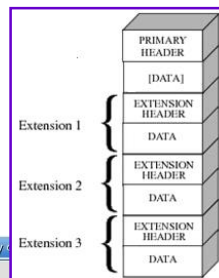
Single Dish



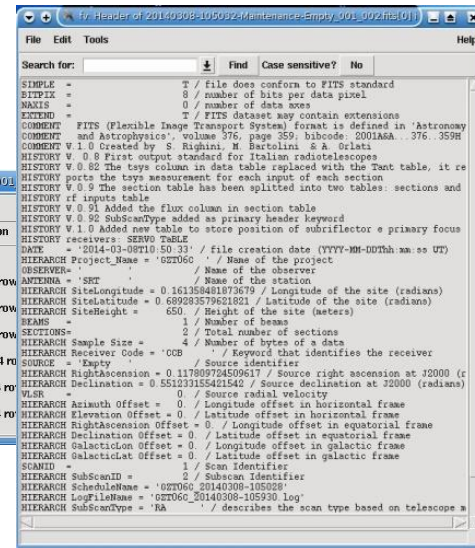
Pulsar
Single Dish/VLBI



VLBI FITS-IDI



Single-dish FITS

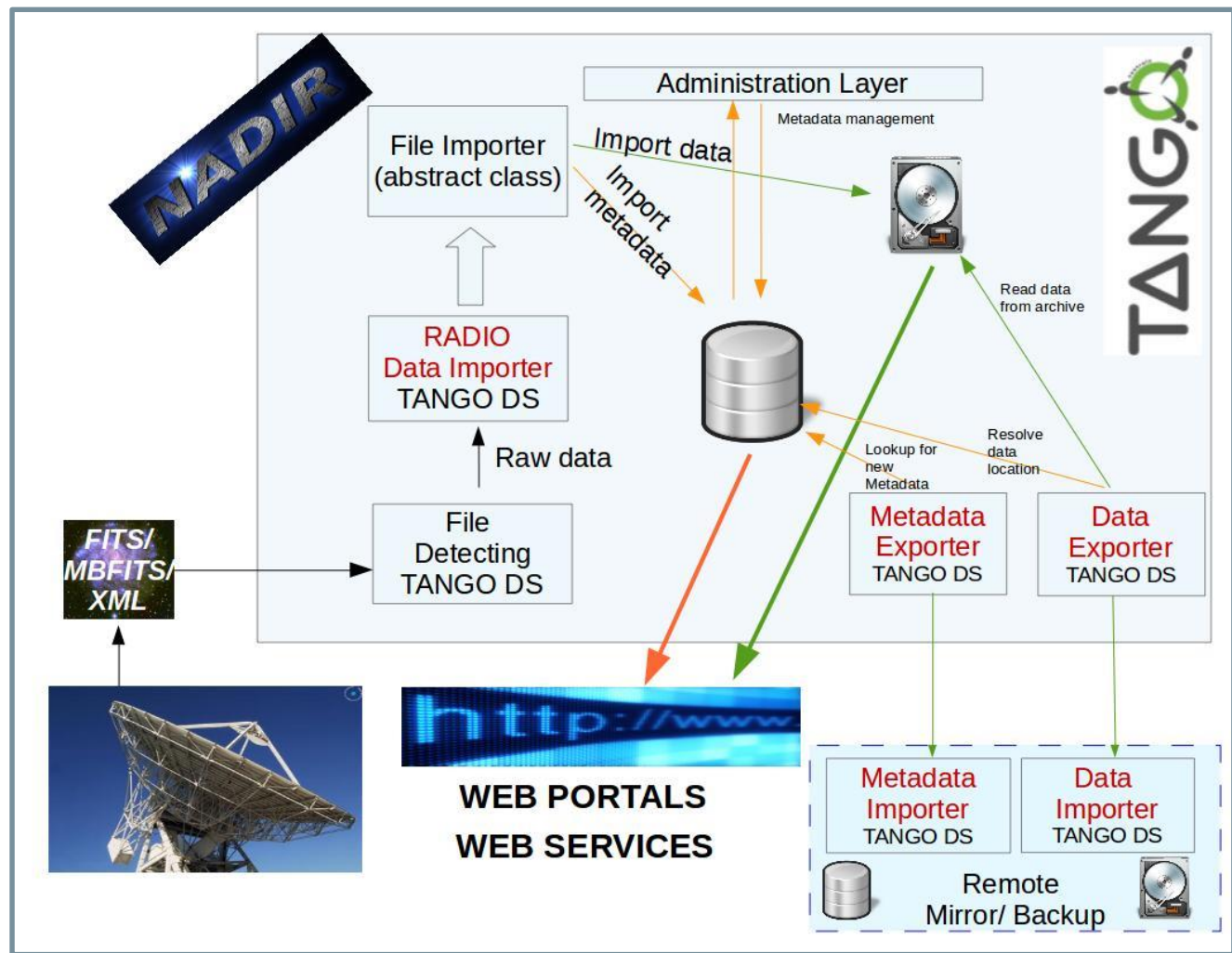


Index	Extension	Type	Dimension	View				
0	Primary	Image	0	Header	Image	Table		
1	ARRAY_GEOMETRY	Binary	7 cols X 2 rows	Header	Hist	Plot	All	Select
2	SOURCE	Binary	26 cols X 4 rows	Header	Hist	Plot	All	Select
3	ANTENNA	Binary	13 cols X 18 rows	Header	Hist	Plot	All	Select
4	FREQUENCY	Binary	6 cols X 1 rows	Header	Hist	Plot	All	Select
5	INTERFEROMETER_MODEL	Binary	20 cols X 210 rows	Header	Hist	Plot	All	Select
6	CALC	Binary	11 cols X 5 rows	Header	Hist	Plot	All	Select
7	MODEL_COMPS	Binary	21 cols X 210 rows	Header	Hist	Plot	All	Select
8	UV_DATA	Binary	13 cols X 8410 rows	Header	Hist	Plot	All	Select
9	SYSTEM_TEMPERATURE	Binary	10 cols X 0 rows	Header	Hist	Plot	All	Select
10	PHASE-CAL	Binary	17 cols X 378 rows	Header	Hist	Plot	All	Select

Pulsar data (PSRFITS, Filterbank)

The radio archive architecture

New
Archiving
Distributed
InfrastructuRe



Towards FAIRness

- Archived raw data must be discoverable and (re)usable
- Variety of observing projects and heterogeneity of the data:
accurate characterisation → scientific exploitation of the Archive
- General users must be able to address
 - ✓ if the data are suitable their own research
 - ✓ if all the necessary information for data exploitation is available
- Global data discovery and access requires to expose a uniform, standard data model

The IVOA Radio Interest Group



“Enhancing interoperable data access to radio data has become a science priority within the International Virtual Observatory Alliance (IVOA). This lead to the foundation of the IVOA Radio astronomy Interest Group...Together they are paving the way to a better integration of their services in the virtual observatory (VO) infrastructure and propose extension of IVOA standards to help achieving this goal. ” (Louys et al 2020)

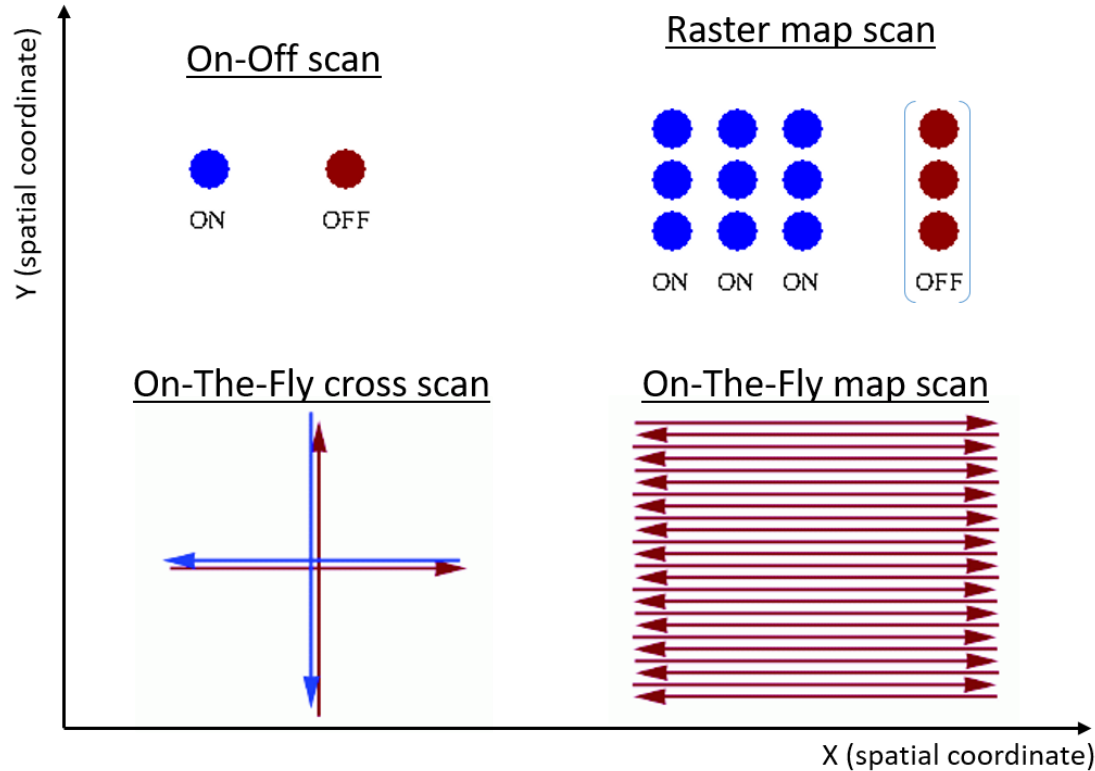
Main tasks:

- development of use cases for data discovery, access and visualization
- identification of metadata concepts needed by radio astronomy data that are not currently supported by the VO

Mapping INAF radio data into VO data models

- INAF radio data are compliant with the mandatory components of the VO ObsCore Data Model for discovery purposes
- However, to improve the discoverability some peculiarities have to be accounted for and better described (especially for SD and VLBI data)
- Example: spatial (geometrical) properties, frequency setup, time domain, UV coverage & c.

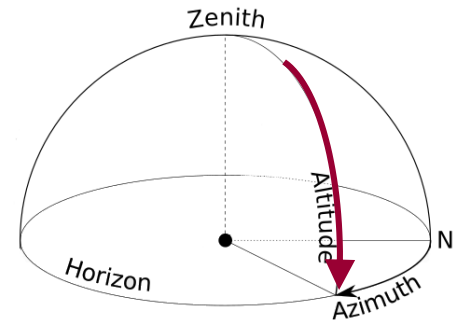
Some examples: single dish & geometry



Frequency switching



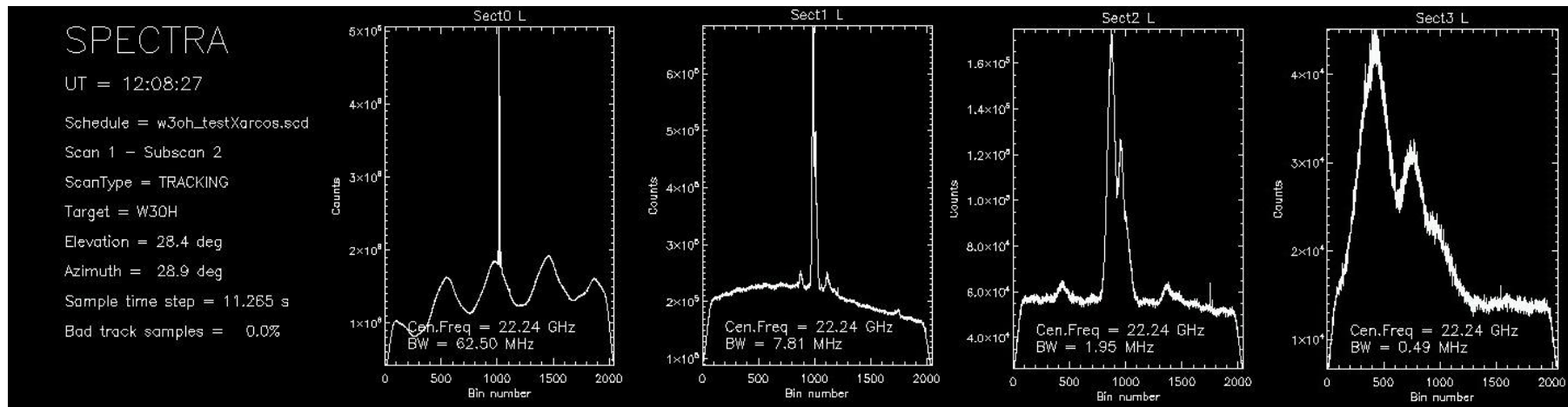
Skydip



Some examples: single dish & frequency setup(s)

It is possible to have more than one spectral window in the same scan, differing in bandwidth and spectral resolution. Examples:

- each spectral window is centered at a different frequency
- spectral windows at same frequency with increasing resolution (“zoom mode”)



Multifrequency setup

☒ Wobbler☒ Creator☒ Format version[Download](#)[Edit query](#)

Rows displayed

<input checked="" type="checkbox"/>	File name	Policy	Proj id	RA	Dec	Obs date	Freq min [MHz]	Freq max [MHz]	Bandwidth [MHz]	Spec res [MHz]	Rest freq [MHz]	Freq bins	Pol
<input type="checkbox"/>	20190406-040544-13-19-G358.93-0.03.tar	FREE	13-19	17:43:10.020	0-29:51:45.80	2019-04-06T04:05:55	22235.18475	22242.99725	7.8125	0.0038146973	22235.07985	2048	LCP
<input type="checkbox"/>	20190419-025725-13-19-G358.93-0.03.tar	FREE	13-19	17:43:10.020	0-29:51:45.80	2019-04-19T02:57:36	22235.18475	22242.99725	7.8125	0.0038146973	22235.07985	2048	RCP
<input type="checkbox"/>	20190422-013655-13-19-Skydip.tar	FREE	13-19	13:14:18.508	27:15:49.20	2019-04-22T01:36:56	22238.1144375	22240.0675625	1.953125	9.5367432E-4	22235.07985	2048	LCP
<input type="checkbox"/>	20190422-014516-13-19-3C286.tar	FREE	13-19	13:31:08.280	30:30:33.12	2019-04-22T01:45:17	22238.1144375	22240.0675625	1.953125	9.5367432E-4	22235.07985	2048	RCP
<input type="checkbox"/>	20190422-015546-13-19-G358.93-0.03.tar	FREE	13-19	17:43:10.020	0-29:51:45.80	2019-04-22T01:55:57	22238.8468594	22239.33514065	0.48828125	2.3841858E-4	22235.07985	2048	LCP

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22238.8468594	22239.33514065	0.48828125	2.3841858E-4	22235.07985	2048	LCP
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22207.841	22270.341	62.5	0.030517578	22235.07985	2048	LCP
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Multifrequency setup

☒ Wobbler

☒ Creator

☒ Format version

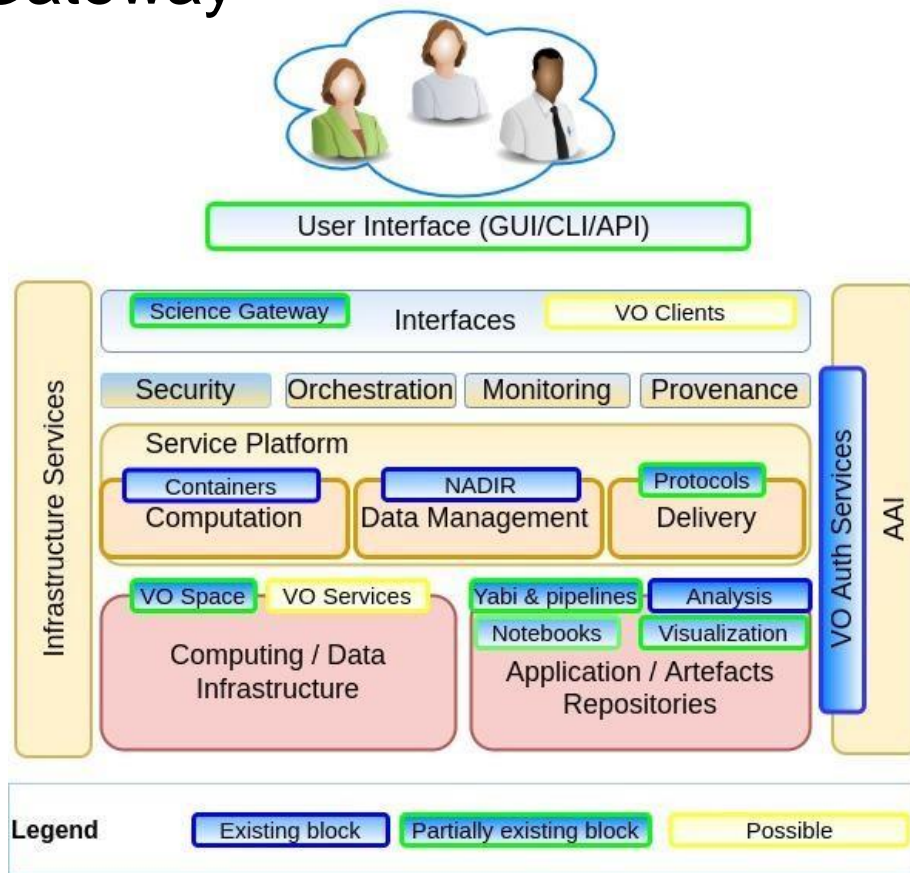
Download ▾ </> Edit query

<input checked="" type="checkbox"/> <input type="checkbox"/> File name	Policy	Proj id	Re
<input type="checkbox"/> 20190406-040544-13-19-G358.93-0.03.tar	FREE	13-19	17
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An Italian radio Science Gateway

- Processing pipelines, quality metrics etc.
- Visualisation & graphical information
- Definition of additional metadata to describe the process (reproducibility)
- Build on SKA DC experience/infrastructure



Summary

- Data from INAF radio telescopes discoverable and accessible in a public, web-based archive.
- Almost ready to be discoverable in the VO: publishing coming soon
- Enhance interoperability: the VO RadiolG
- Further steps towards FAIRness
- Towards an infrastructure for discoverability and usability of data: first prototype of Italian Science Gateway