

# L'applicazione del VO Data Model all'archivio INAF dei dati radio

Alessandra Zanichelli – INAF IRA

# The present @ SRT, Med, Noto



- Common Single-Dish Control System (DISCOS): integrated backends, common data format



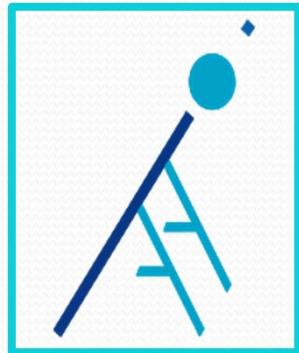
- SRT in operation + expertise in software cross correlation: «Italian» VLBI Network experiments (EVN subarrays)



➡ Need for a modern, public radio archive

# Towards a public Radio Archive

- Collaboration with the INAF Italian Astronomical Archive Data Centre
- In 2012 start to define the requirements for a radio data archive:
  - Common data model for SD and VLBI
  - Archive architecture
  - Web interface
  - Virtual Observatory



# Data formats @ SRT, Med, Noto

**MBFITS**

```
alex@honeypot:~/escs/mbfits/medicina/20121008/20121008-120852-140526-libardi_3C286> ls -la
total 12
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 .
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 ..
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 MBF-ROOT
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 SCAN.fits
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 <FEBE-NAME>-FEBEPAR.fits
d--/ 1 alex alex 4096 2013-02-21 13:01 <FEBE-NAME>-ARRAYDATA-<1>.fts
d--/ 1 alex alex 4096 2013-02-21 13:01 <FEBE-NAME>-ARRAYDATA-<k>.fts
d--/ 1 alex alex 4096 2013-02-21 13:01 <FEBE-NAME>-DATAPAR.fits
...
d--/ 1 alex alex 4096 2013-02-21 13:01 CCC-Backend-FEBEPAR.fits
d--/ 1 alex alex 23040 2013-02-21 13:01 GROUPING.fits
d--/ 1 alex alex 10000 2013-02-21 13:01 FEBEPAR.fits
...
alex@honeypot:~/escs/mbfits/medicina/20121008/20121008-120852-140526-libardi_3C286> ls -la 0002
total 12
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 .
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 ..
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 CCC-Backend-ARRAYDATA-01.fits
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 CCC-Backend-ARRAYDATA-02.fits
drwxr-xr-x 2 alex alex 86400 2013-02-21 13:01 CCC-Backend-DATAPAR.fits
drwxr-xr-x 2 alex alex 17280 2013-02-21 13:01 MONITOR.fits
...
alex@honeypot:~/escs/mbfits/medicina/20121008/20121008-120852-140526-libardi_3C286>
```

**FITS**

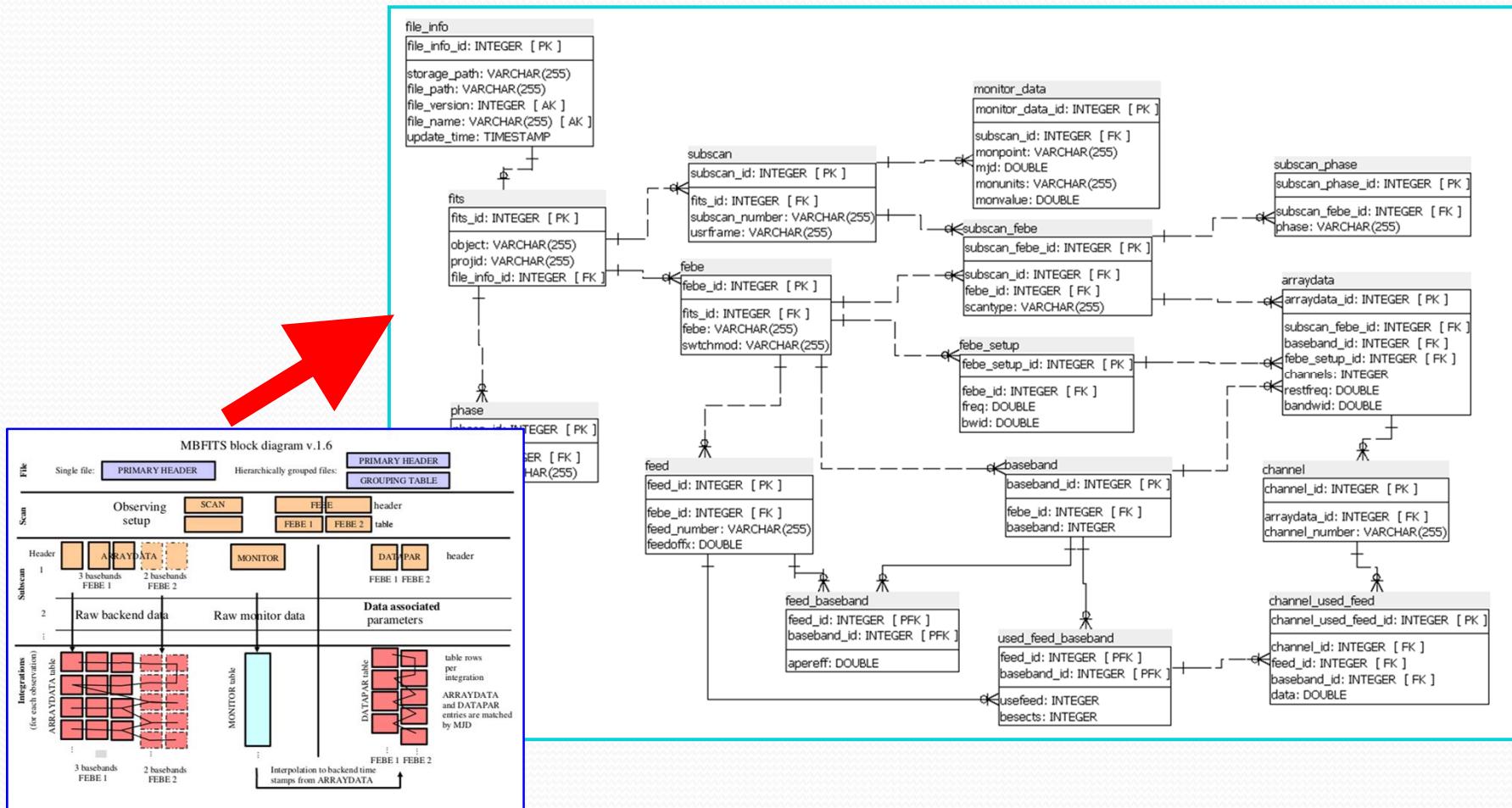
Index	Extension	Type	Dimension
0	Primary	Image	0
1	SECTION TABLE	Binary	5 cols X 2 rows
2	RF INPUTS	Binary	9 cols X 2 rows
3	FEED TABLE	Binary	4 cols X 1 rows
4	DATA TABLE	Binary	12 cols X 364 rows
5	ANTENNA TEMP TABLE	Binary	2 cols X 364 rows
6	SERVO TABLE	Binary	8 cols X 364 rows

**VLBI FITS**

Index	Extension	Type	Dimension	View
0	Primary	Image	0	Header Image Table
1	ARRAY_GEOOMETRY	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**

# A common data model



# Astronomical data preservation

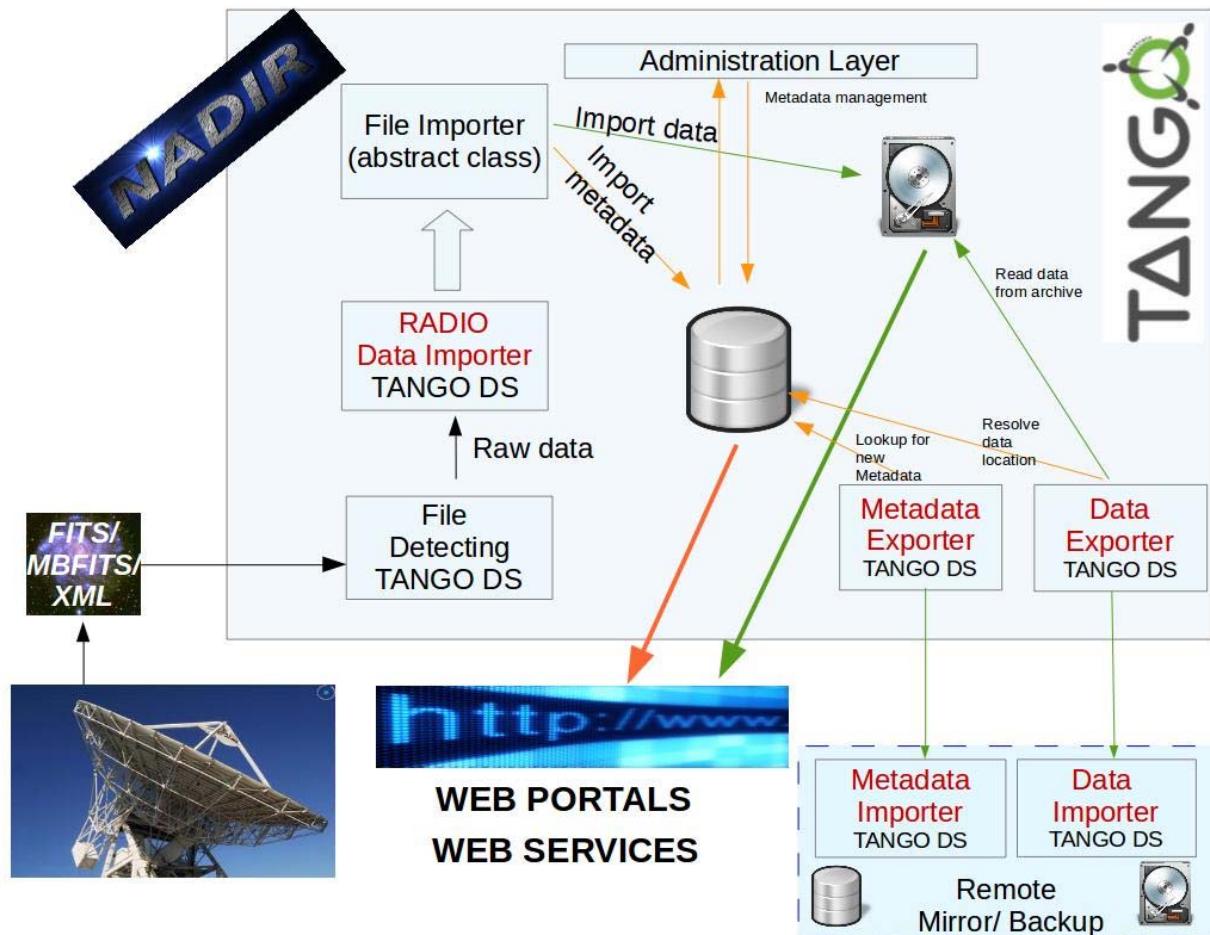
Observations comprise:

- The scientific exposures
- The data+instrument+site metadata
- The observing schedule
- The observing and telescope(s) logs

All this information is needed (and archived!) to guarantee data reuse, preservation and curation

➡ **scientific exploitation**

# Radio Archive architecture



# Radio Archive features

- Web GUI
- All data public after a proprietary period: INAF policy
- Who are the users? PI, general public, telescope staff.  
Authentication & Authorization (SSO)
- VO-compliant services

# The Radio Archive Web Interface



# The Radio Archive Web Interface

Home      Login

## Radio Archive

Simple search    VLBI-IT search    SD search

Degrees    File name

Decimal degrees

RA  hh.mm.ss.sss    Dec  dd.mm.ss.sss    Radius  arcmin

Observation Date    From:  YYYY-MM-DD    To:  YYYY-MM-DD

Frequency    MIN:  MAX:

Project ID

# The Radio Archive



Home      Login

## Radio Archive

Simple search      VLBI-IT search      SD search

Degrees      File name

Decimal degrees

RA  Dec  Radius  arcmin

Observation Date From:  To:

Frequency MIN:  MAX:

Project ID

Telescope VLBI-IT

PI Name

Exposure Time

Antennas  Any antennas  Select antennas  Medicina  
 Noto  
 SRT

Data Rate

Channels

Channel Resolution

A red oval highlights the "VLBI-IT search" button.

# The Interface

The screenshot shows a web-based search interface for a Radio Archive. At the top, there is a navigation bar with links for "Home" and "Login". Below the navigation bar, there is a header with the text "Radio Archive" and a small image of a satellite dish. The main search area has three tabs: "Simple search", "VLBI-IT search", and "SD search". The "SD search" tab is circled in red. The search form includes fields for "File name" and "Degrees" (with a "Decimal degrees" option selected). There are numerous search criteria listed in pairs of checkboxes and input fields, such as "RA [hh.mm.ss.sss] Dec [dd.mm.ss.sss] Radius [arcmin]", "Observation Date [From: YYYY-MM-DD To: YYYY-MM-DD]", "Frequency MIN: [ ] MAX: [ ]", "Project ID [ ]", "Telescope [Any | ▾]", "Frontend [Any | ▾]", "Backend [Any | ▾]", "Bandwidth [ ]", "Eqinox [2000 | ▾]", "Exposure Time [ ]", "LST Min: [hh.mm.ss.sss] Max: [hh.mm.ss.sss]", "Scan Type [Any | ▾]", "Scan Mode [Any | ▾]", "Scan Geometry [Any | ▾]", "Switch Mode [Any | ▾]", "Frequency Resolution [ ]", "Rest Frequency [ ]", "Scan Frame [Any | ▾]", "Frequency Beans [ ]", "Scan Speed [ ]", "Wobbler [Any | ▾]", "Wobbler [Any | ▾]", "Observer [ ]", "Creator [ ]", and "Format Version [ ]". At the bottom of the search form are "Search" and "Reset" buttons.

The Radio Archive



Home      Login

Degrees      File

<u>Decimal_degrees</u>	File	dateobs	ra_char	dec_char	projid	min_freq	max_freq
<input checked="" type="checkbox"/>	<a href="#">20100128-221111-3C286.tar.gz</a>	2010-01-28T22:11:11	13:31:08.287	30:30:32.96	13-10	5000	5150
<input type="checkbox"/>	<a href="#">20100128-221111-3C286.tar.gz</a>	2010-01-28T22:11:11	13:31:08.287	30:30:32.96	13-10	7000	7330
<input checked="" type="checkbox"/>	<a href="#">20120229-030455-test.tar.gz</a>	2012-02-29T03:04:55	04:37:04.375	29:40:13.82	23-12	5800	6400
<input type="checkbox"/>	<a href="#">20120229-030455-test.tar.gz</a>	2012-02-29T03:04:55	04:37:04.375	29:40:13.82	23-12	6500	7100
<input type="checkbox"/>	<a href="#">20120229-040455-3C123.tar.gz</a>	2012-02-29T04:04:55		29:40:13.82	23-12	5800	6400
<input type="checkbox"/>	<a href="#">20120229-040455-3C123.tar.gz</a>	2012-02-29T04:04:55		29:40:13.82	23-12	6500	8548
<input type="checkbox"/>	<a href="#">20120728-030455-test.tar.gz</a>	2012-07-28T03:04:55	00:27:00.000	31:35:00.00	13-10	5200	5530
<input type="checkbox"/>	<a href="#">20120728-030455-test.tar.gz</a>	2012-07-28T03:04:55	00:27:00.000	31:35:00.00	13-10	4800	4950
<input type="checkbox"/>	<a href="#">20120728-030455-test.tar.gz</a>	2012-07-28T03:04:55	00:27:00.000	31:35:00.00	13-10	5000	5330
<input type="checkbox"/>	<a href="#">20150129-221111-3C286.tar.gz</a>	2015-01-29T22:11:11	13:31:08.287	30:30:32.96	13-10	18000	18150
<input type="checkbox"/>	<a href="#">20150129-221111-3C286.tar.gz</a>	2015-01-29T22:11:11	13:31:08.287	30:30:32.96	13-10	20000	20330
<input type="checkbox"/>	<a href="#">20150129-221111-3C286.tar.gz</a>	2015-01-29T22:11:11	13:31:08.287	30:30:32.96	13-10	22000	22330
<input type="checkbox"/>	<a href="#">20150303-210000-source1.tar.gz</a>	2015-03-03T21:00:00	09:41:57.300	87:48:17.77	3-15	4800	4950
<input type="checkbox"/>	<a href="#">20150603-210000-source1.tar.gz</a>	2015-06-03T21:00:00	09:41:57.300	87:48:17.77	3-15		
<input type="checkbox"/>	<a href="#">20140128-211111-3C286.tar.gz</a>	2014-01-28T21:11:11	13:31:08.287	30:30:32.96	13-10	4800	4950
<input type="checkbox"/>	<a href="#">20140128-211111-3C286.tar.gz</a>	2014-01-28T21:11:11	13:31:08.287	30:30:32.96	13-10	5000	5330
<input type="checkbox"/>	<a href="#">20140128-211111-3C286.tar.gz</a>	2014-01-28T21:11:11	13:31:08.287	30:30:32.96	13-10	5200	5530
<input type="checkbox"/>	<a href="#">20150917-132441-maintenance-w3oh.tar.gz</a>	2015-09-17T13:24:41	10:05:26.074	73:20:00.06	15-17	22000	22600
<input type="checkbox"/>	<a href="#">20150917-132441-maintenance-w3oh.tar.gz</a>	2015-09-17T13:24:41	10:05:26.074	73:20:00.06	15-17	22100	22550
<input type="checkbox"/>	<a href="#">20150917-142836-maintenance-w3oh.tar.gz</a>	2015-09-17T14:31:15	02:27:04.100	61:52:27.10	15-15	22000	22600
<input type="checkbox"/>	<a href="#">20150917-142836-maintenance-w3oh.tar.gz</a>	2015-09-17T14:31:15	02:27:04.100	61:52:27.10	15-15	22100	22550
<input type="checkbox"/>	<a href="#">20150917-142836-maintenance-w3oh.tar.gz</a>	2015-09-17T14:31:15	02:27:04.100	61:52:27.10	15-15	22150	22450
<input type="checkbox"/>	<a href="#">20150917-143104-maintenance-w3oh.tar.gz</a>	2015-09-17T15:11:15	02:27:04.100	61:52:27.10	15-21	2900	4900
<input type="checkbox"/>	<a href="#">20150917-145106-maintenance-w3oh.tar.gz</a>	2015-09-17T15:21:15	02:27:04.100	00:00:01.74	15-08	2900	4900
<input type="checkbox"/>	<a href="#">20150917-145943-maintenance-w3oh.tar.gz</a>	2015-09-17T01:30:45	02:27:04.100	00:00:01.74	15-03	20900	22900
<input type="checkbox"/>	<a href="#">20150917-150250-maintenance-w3oh.tar.gz</a>	2015-09-17T11:30:45	02:27:04.100	00:00:01.74	15-14	20900	22900
<input type="checkbox"/>	<a href="#">20150917-132644-maintenance-w3oh.tar.gz</a>	2015-09-17T13:26:41	10:05:26.074	73:20:00.06	15-03	22000	22600
<input type="checkbox"/>	<a href="#">20150917-132644-maintenance-w3oh.tar.gz</a>	2015-09-17T13:26:41	10:05:26.074	73:20:00.06	15-03	22100	22550
<input type="checkbox"/>	<a href="#">20150917-125302-maintenance-w3oh.tar</a>	2015-09-17T13:11:15	02:27:04.100	61:52:27.10	15-01	22100	22550
<input type="checkbox"/>	<a href="#">20150917-125302-maintenance-w3oh.tar</a>	2015-09-17T13:11:15	02:27:04.100	61:52:27.10	15-01	22150	22450
<input type="checkbox"/>	<a href="#">20150917-125302-maintenance-w3oh.tar</a>	2015-09-17T13:11:15	02:27:04.100	61:52:27.10	15-01	22000	22600

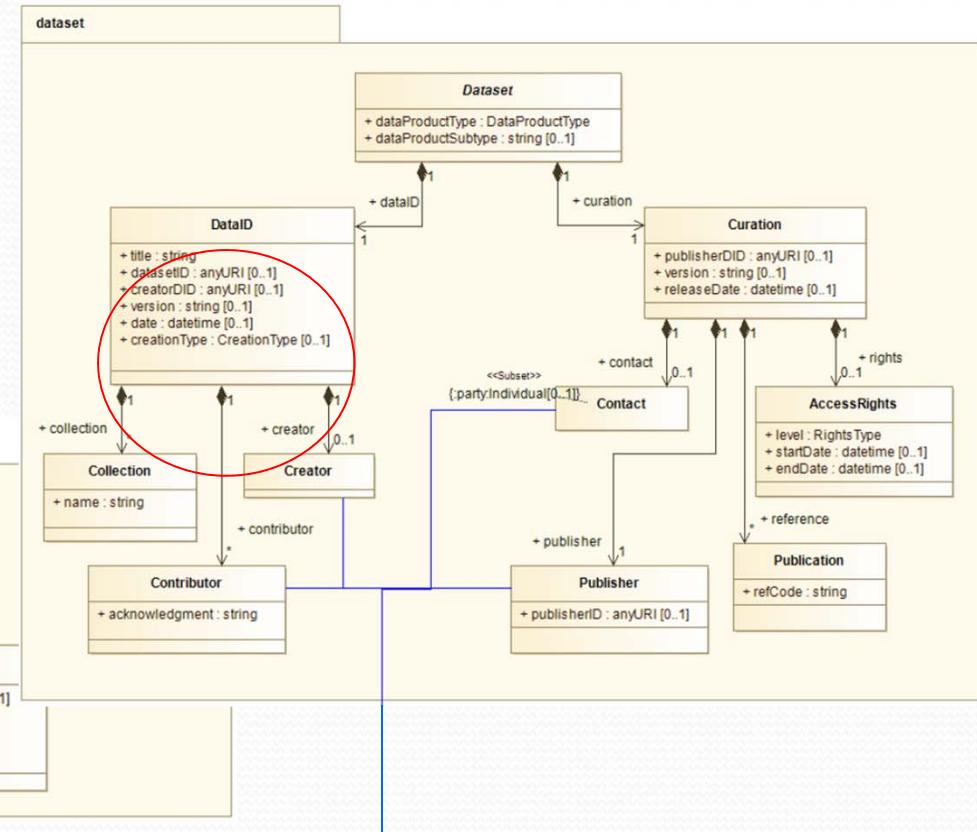
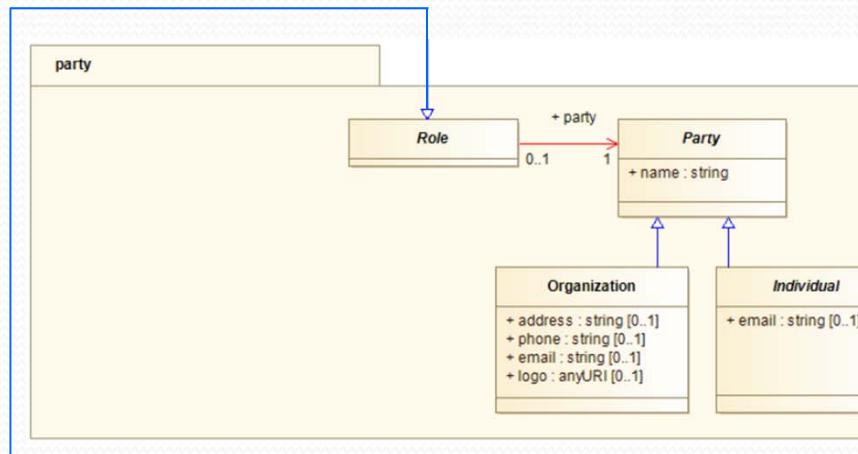
# The VO perspective

- Analysis of VO Dataset Metadata Model
- Analysis of VO ObsCore mandatory components
- A look at the CAOM model
- TAP service and data access via DataLink

# VO Dataset Metadata Model

Generic high-level metadata needed to describe a file or files which are considered to be a single deliverable (IVOA Dataset).

➡ Radio dataset case:  
Dataset Metadata are saved either in the dataset itself or in the database.

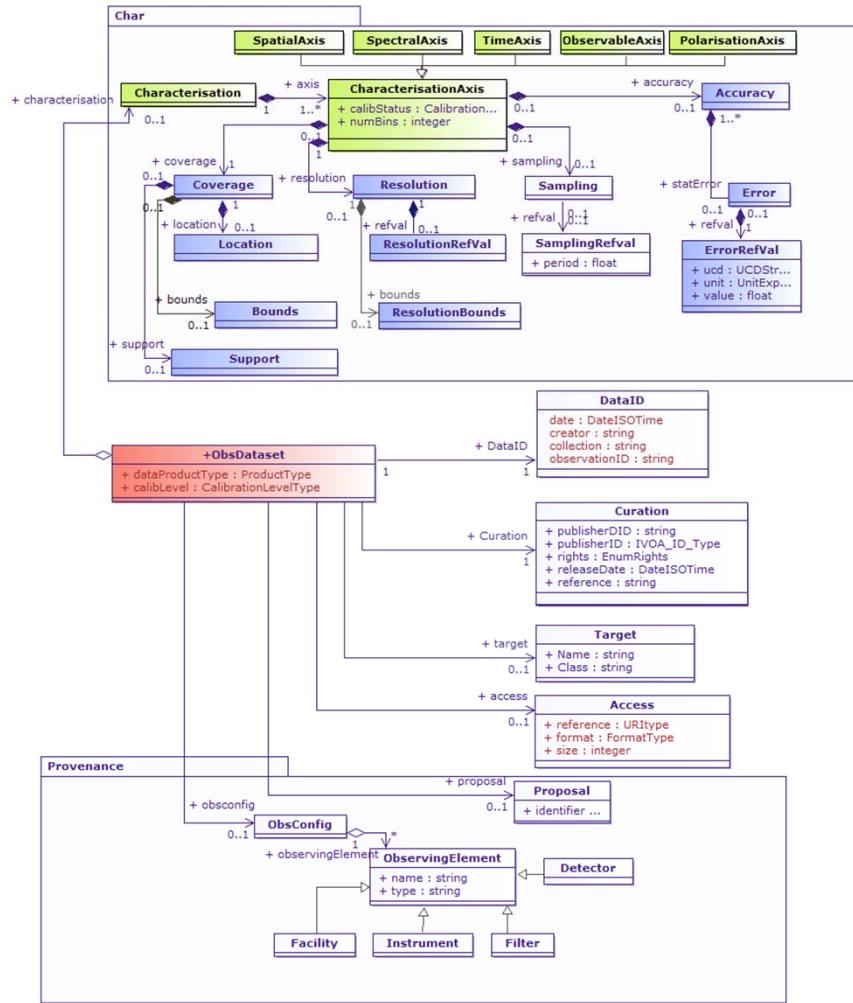


# VO ObsCore

Global data discovery and access  
(multiple TAP, many archives)  
requires to expose  
a uniform, standard data model.

Analysis of the VO ObsCore  
**mandatory** components.

For (at least) data discovery purposes, all the required metadata core components are present in the radio data model.



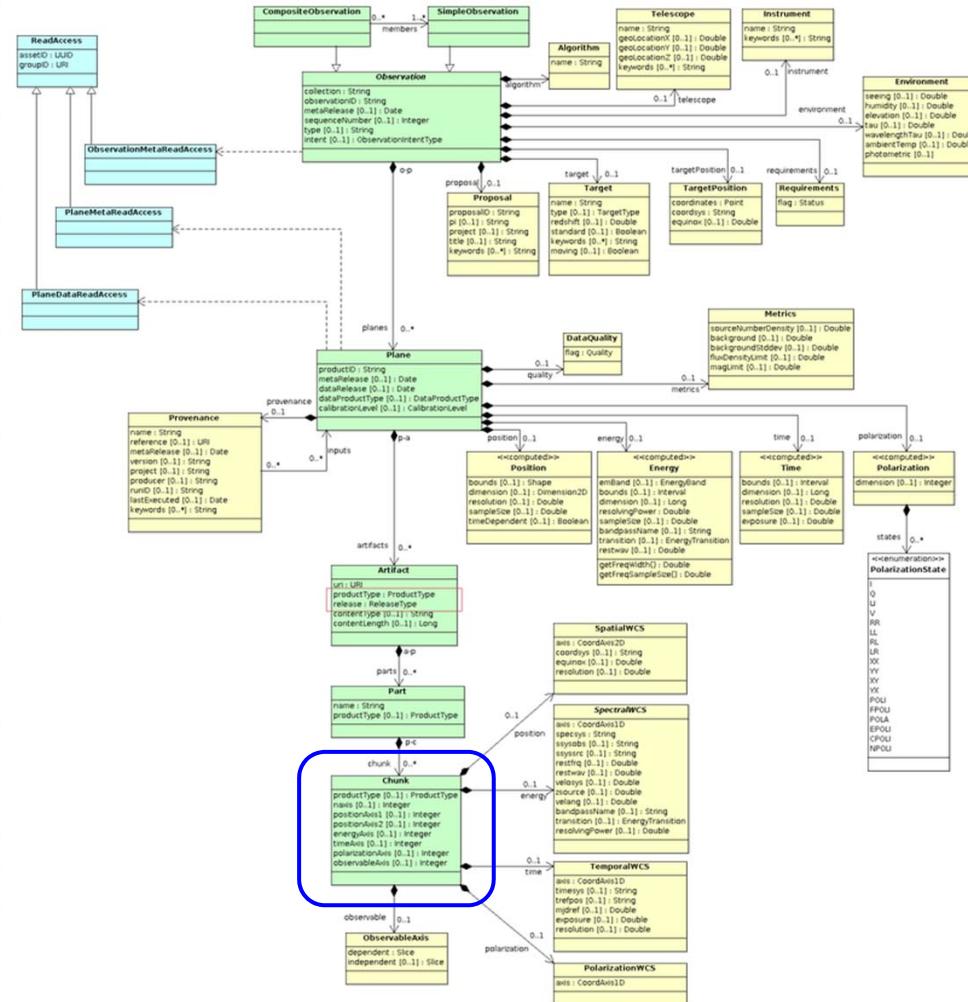
# The CAOM Model

Common Archival Observation  
Model @ CADC

CompositeObservation  
-> Observing Project

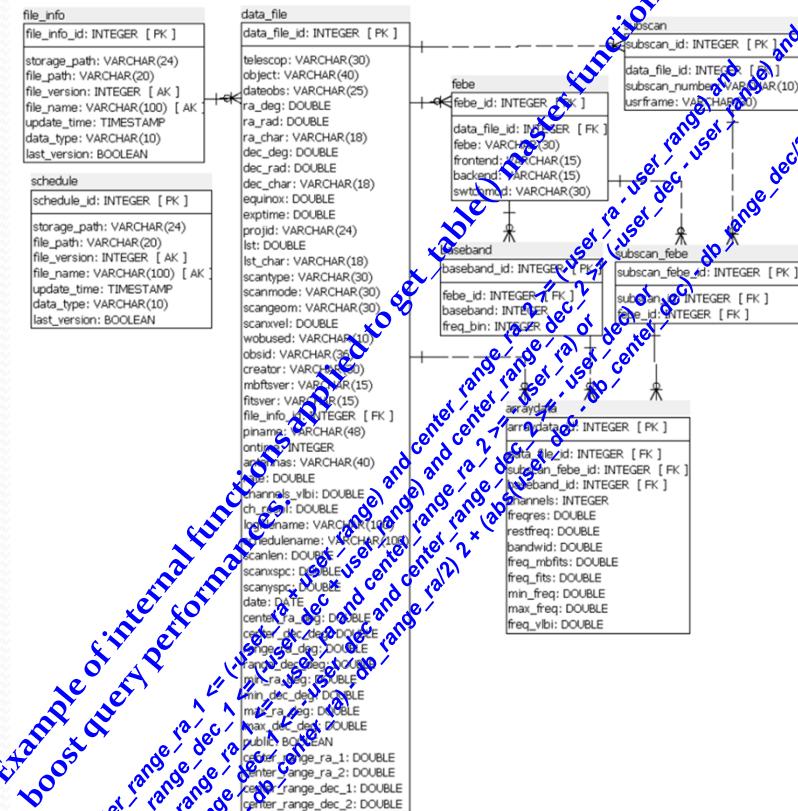
Artifacts -> tar files / MBFits

Chunk -> single subscan or file  
denormalized



# TAP and DataLink

- TAP service:
  - IA2 implementation
  - custom User Defined Functions to improve query performance  
 $\text{get\_table} = f(\text{pos}, \text{freq}, \dots);$   
 $\text{pos} = f(\text{ra}, \text{dec}, \text{rad}, \dots);$
  - UDF at TAP level? (TBD)
- DataLink access to datasets
  - Access to complex datasets: content list, ancillary resources (related datasets)
  - additional metadata (provenance, data quality, etc.)



Example of internal functions available to get table/master function to boost query performance:  
center\_range\_ra\_1 < (user\_ra - user\_ra\_1) & center\_range\_ra\_1 > (user\_ra + user\_ra\_1) & center\_range\_dec\_1 < (user\_dec - user\_dec\_1) & center\_range\_dec\_1 > (user\_dec + user\_dec\_1) & abs(user\_ra - user\_ra\_2) < user\_ra\_2 \* abs(user\_ra - user\_ra\_2) & abs(user\_dec - user\_dec\_2) < user\_dec\_2 \* abs(user\_dec - user\_dec\_2) & (abs(user\_ra - user\_ra\_2) < user\_ra\_2 \* user\_ra\_2) & (abs(user\_dec - user\_dec\_2) < user\_dec\_2 \* user\_dec\_2)

# Conclusions



- Public Archive for the Italian radio telescopes: definition of a common data model, flexible architecture
- Web interface: definition of query parameters, SSO
- The Radio Archive and the VO: ready to go



AI 17-18