



Data Models for Radio Astronomy

Juan de Dios Santander Vela (IAA-CSIC)
AMIGA collaboration

Multi-wavelength Astronomy and the Virtual Observatory Workshop
Villafranca del Castillo, 01/12/2008

Talk Overview

— [The AMIGA project (in one slide!)

— [Data Models

— [IVOA and Data Modeling

— [Data modeling for radio astronomy: RADAMS

— [Conclusions

AMIGA

Analasys of the interstellar
Medium of Isolated GALaxies

CIG
(Catalogue of Isolated Galaxies)
Karachentseva 1973)

Refinement

Positions

Velocity

mB/LB

Morphologies

Isolation

AMIGA sample

Technical development

Global

Selected subsamples

mm/submm
calibration

Archiving

Tools

SF/AGN

FIR

radiocont

SDSS spectra

H α

CO/HCN

HI

Kinem/dyn

HI, H α

GCs

SF inner

H α

CO/HCN

SF outer

HI

CO

XUV

Phase transfer



Fast switching

VO compliant

MOVOIR

3D data analysis
GIPSY



VO compliant

Data model

Web Interface



Robledo

30-IRAM

Data Models

Data Model: Definition

Detailed description of the **set of entities** needed for useful **information storage** and retrieval within a **particular field**, specifying both stored data and their **relationships**.

focus on “**metadata**”, not **data**

Structuring Information

Juan de Dios Santander Vela

jdsant@iaa.es

Instituto de Astrofísica de Andalucía (CSIC)

VO Devel. Contract (01/2007-12/2008)

13P CSIC Grant (01/2006-12/2006)

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**DMS are
domain and application
dependent!**

Structuring Information

- [Data Model elements

- Entities (Classes in OOP/XML)

- Fields (Attributes in OOP/XML)

- Data types

- Relationships

- Semantics

Structuring Information

— [Data Model elements

— Entities (Classes in OOP/XML)

— Fields (Attributes in OOP/XML)

— Data types

— Relationships

— Semantics

Remember!
This is just
VO infrastructure

Structuring Information

Attributes and Data Types

Field	ObjID	Name	RA	Dec	Epoch
Type	BigInt	String	Float	Float	String
Examples	3123453445 OBGGALAX_1	'CIG 96' 96	132.3478 8h12°50'52''	-05.3345 0h5°20'42''	'J2000' 'Epoch J2000'

Structuring Information

Semantics and UCDs

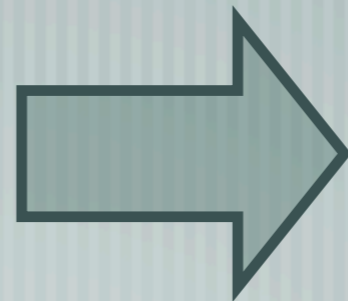
Field	ObjID	Name	RA	Dec	Epoch
Meaning	Object code	Object name	Right Ascension	Declination	Epoch code
UCD	meta.id; meta.code	meta.id; meta.name	pos.eq.ra; meta.main	pos.eq.dec; meta.main	meta.code; time.epoch

Data Models and InterOp

- [Interoperability

- Common data formats

- Common data models



just one leg

- Common access protocols

- Plus easy communication between tools

IVOA and Data Modeling

IVOA and Data Modeling

Welcome to the IVOA TWiki!

This is the web-based collaboration area of the **International Virtual Observatory Alliance**



Main topics:

- [Who is Who?](#)
- [Documents and Standards](#)
- [Events](#)
- [Training Materials](#)
- [Exec Reports & Minutes](#)
- [Mailing Lists](#)
- [Technical Coordination Group](#)

Working Groups:

- [Applications](#)
- [Semantics](#)
- [Data Access Layer](#)
- [VO Event](#)
- [Data Modeling](#)
- [VO Query Language](#)
- [Grid & Web Services](#)
- [VOTable](#)
- [Resource Registry](#)

Interest Groups:

- [Theory](#)
- [OGF Astro-RG](#)
- [Data Curation & Preservation](#)

Other Groups / Committees:

- [Standing Committee on Standards & Processes](#)
- [InterOp Programme Organising Committee](#)

List of Initial working Draft documents (version < 1.0): [InitialWorkingDrafts](#)

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Data Models in IVOA

Technical Specifications

Group	Title	Most stable	In progress	Version history																
App	Simple Application Messaging Protocol	1.10		1.10	1.00															
DAL	Simple Cone Search	1.03		1.03	1.02	1.01	1.00													
	Simple Image Access	1.01		1.01	1.00															
	Simple Spectral Access	1.04		1.04	1.03	1.02	1.01	1.01	1.00											
DaM	Space-Time Coordinate Metadata for the Virtual Observatory (STC)	1.33		1.33	1.31	1.30	1.21	1.20	1.10	1.00										
	Data Model for Astronomical DataSet Characterisation	1.13		1.13	1.12	1.12	1.11	1.10	1.00											
	IVOA Spectral Data Model	1.03		1.03	1.02	1.01	1.01	1.01	1.00											
GWS	IVOA Single-Sign-On Profile: Authentication Mechanisms	1.01		1.01	1.01	1.00	1.00													
	VOSpace service specification	1.02	1.14 RFC	1.14	1.13	1.12	1.12	1.11	1.10	1.02	1.02	1.01	1.00	1.00						
	IVOA Credential Delegation Protocol	1.01	RFC	1.01	1.01	1.00														
	IVOA support interfaces	1.00		1.00																
ReR	IVOA Web Service Basic Profile	1.00		1.00																
	IVOA Identifiers	1.12		1.12	1.11	1.10	1.10	1.10	1.00											
	IVOA Registry Interfaces	1.01	RFC	1.01	1.00															
	Resource Metadata for the Virtual Observatory	1.12		1.12	1.12	1.10	1.10	1.01	1.01	1.00	1.00									
Semantics	VOResource: an XML Encoding Schema for Resource Metadata	1.03		1.03	1.02	1.02	1.01	1.00												
	An IVOA standard for Unified Content Descriptors	1.10		1.10	1.10	1.06	1.05	1.03												
	UCD1+ Controlled Vocabulary	1.23		1.23	1.22	1.21	1.20	1.20	1.11	1.11	1.10	1.02	1.00							
	Maintenance of the list of UCD words	1.20		1.20	1.20	1.10	1.00													
Vocabularies in the Virtual Observatory		1.16	RFC	1.16	1.15	1.13	1.00													
		1.00	1.10 RFC	1.10	1.10	1.00	1.00													
SDP	IVOA Document Standards	1.00																		
VOE	Sky Event Reporting Metadata (VOEvent)	1.11		1.11	1.11	1.10	1.01													
VQL	IVOA Astronomical Data Query Language	2.00		2.00	2.00	2.00	1.01	1.00												
	IVOA SkyNode Interface	1.01		1.01	1.00															
VOT	VOTable Format Specification	1.10	1.20	1.20	1.10	1.00														

Maturity level: ■ Recommendation ■ Proposed Recommendation ■ Working Draft

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DaM	Space-Time Coordinate Metadata for the Virtual Observatory (STC)	1.33		1.33	1.31	1.30	1.21	1.20	1.10	1.00										
	Data Model for Astronomical DataSet Characterisation	1.13		1.13	1.12	1.12	1.11	1.10	1.00											
	IVOA Spectral Data Model	1.03		1.03	1.02	1.01	1.01	1.01	1.00											
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	VOSpace service specification	1.02	1.14 RFC	1.14	1.13	1.12	1.12	1.11	1.10	1.02	1.02	1.01	1.00	1.00						
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	Resource Metadata for the Virtual Observatory	1.12		1.12	1.12	1.10	1.10	1.01	1.01	1.00	1.00									
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	UCD1+ Controlled Vocabulary	1.23		1.23	1.22	1.21	1.20	1.20	1.11	1.11	1.10	1.02	1.00							
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VOE	Sky Event Reporting Metadata (VOEvent)	1.11		1.11	1.11	1.10	1.01													
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	Data Model for Astronomical DataSet Characterisation	1.13		1.13	1.12	1.12	1.11	1.10	1.00											
	IVOA Spectral Data Model	1.03		1.03	1.02	1.01	1.01	1.01	1.00											
GWS	IVOA Single-Sign-On Profile: Authentication Mechanisms	1.01		1.01	1.01	1.00	1.00													
	VOSpace service specification	1.02	1.14 RFC	1.14	1.13	1.12	1.12	1.11	1.10	1.02	1.02	1.01	1.00	1.00						
	IVOA Credential Delegation Protocol	1.01	RFC	1.01	1.01	1.00														
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	IVOA Web Service Basic Profile	1.00		1.00																
ReR	IVOA Identifiers	1.12		1.12	1.11	1.10	1.10	1.10	1.00											
	IVOA Registry Interfaces	1.01	RFC	1.01	1.00															
	Resource Metadata for the Virtual Observatory	1.12		1.12	1.12	1.10	1.10	1.01	1.01	1.00	1.00									
	VOResource: an XML Encoding Schema for Resource Metadata	1.03		1.03	1.02	1.02	1.01	1.00												
Semantics	An IVOA standard for Unified Content Descriptors	1.10		1.10	1.10	1.06	1.05	1.03												
	UCD1+ Controlled Vocabulary	1.23		1.23	1.22	1.21	1.20	1.20	1.11	1.11	1.10	1.02	1.00							
	Maintenance of the list of UCD words	1.20		1.20	1.20	1.10	1.00													
	Vocabularies in the Virtual Observatory	1.16	RFC	1.16	1.15	1.13	1.00													
SDP	IVOA Document Standards	1.00	1.10 RFC	1.10	1.10	1.00	1.00													
VOE	Sky Event Reporting Metadata (VOEvent)	1.11		1.11	1.11	1.10	1.01													
VQL	IVOA Astronomical Data Query Language	2.00		2.00	2.00	2.00	1.01	1.00												
	IVOA SkyNode Interface	1.01		1.01	1.00															
VOT	VOTable Format Specification	1.10	1.20	1.20	1.10	1.00														

Maturity level: ■ Recommendation ■ Proposed Recommendation ■ Working Draft

Role of Data Models in VO

- [Data Access Protocols (A)

- [Discovery (D) & Evaluation (E)

 - Data selection and quality assessment

- [Transformation (T)

 - Enable maximum quality data transformations

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	Data Model for Astronomical DataSet Characterisation	1.13		1.13	1.12	1.12	1.11	1.10	1.00											
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	VOSpace service specification	1.02	1.14 RFC	1.14	1.13	1.12	1.12	1.11	1.10	1.02	1.02	1.01	1.00	1.00						
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	Simple Image Access	1.01		1.01	1.00															
	Simple Spectral Access	1.04		1.04	1.03	1.02	1.01	1.01	1.00											
DaM	Space-Time Coordinate Metadata for the Virtual Observatory (SES)	1.33		1.33	1.31	1.30	1.21	1.20	1.10	1.00										
	Data Model for Astronomical DataSet Characterisation	1.13		1.13	1.12	1.12	1.11	1.10	1.00											
	IVOA Spectral Data Model	1.03		1.03	1.02	1.01	1.01	1.01	1.00											
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D

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	Data Model for Astronomical DataSet Characterisation ← E	1.13		1.13	1.12	1.12	1.11	1.10	1.00											
GWS	IVOA Spectral Data Model	1.03		1.03	1.02	1.01	1.01	1.01	1.00											
	IVOA Single-Sign-On Profile: Authentication Mechanisms	1.01		1.01	1.01	1.00	1.00													
	VOSpace service specification	1.02	1.14 RFC	1.14	1.13	1.12	1.12	1.11	1.10	1.02	1.02	1.01	1.00	1.00						
	IVOA Credential Delegation Protocol	1.01	RFC	1.01	1.01	1.00														
ReR	IVOA support interfaces	1.00		1.00																
	IVOA Web Service Basic Profile	1.00		1.00																
	IVOA Identifiers	1.12		1.12	1.11	1.10	1.10	1.10	1.00											
	IVOA Registry Interfaces	1.01	RFC	1.01	1.00															
Semantics	Resource Metadata for the Virtual Observatory	1.12		1.12	1.12	1.10	1.10	1.01	1.01	1.00	1.00									
	VOResource: an XML Encoding Schema for Resource Metadata	1.03		1.03	1.02	1.02	1.01	1.00												
	An IVOA standard for Unified Content Descriptors	1.10		1.10	1.10	1.06	1.05	1.03												
	UCD1+ Controlled Vocabulary	1.23		1.23	1.22	1.21	1.20	1.20	1.11	1.11	1.10	1.02	1.00							
SDP	Maintenance of the list of UCD words	1.20		1.20	1.20	1.10	1.00													
	Vocabularies in the Virtual Observatory	1.16	RFC	1.16	1.15	1.13	1.00													
VOE	IVOA Document Standards	1.00	1.10 RFC	1.10	1.10	1.00	1.00													
VQL	Sky Event Reporting Metadata (VOEvent)	1.11		1.11	1.11	1.10	1.01													
VOT	IVOA Astronomical Data Query Language	2.00		2.00	2.00	2.00	1.01	1.00												
	IVOA SkyNode Interface	1.01		1.01	1.00															
	VOTable Format Specification	1.10	1.20	1.20	1.10	1.00														

Maturity level: ■ Recommendation ■ Proposed Recommendation ■ Working Draft

Data Models in IVOA

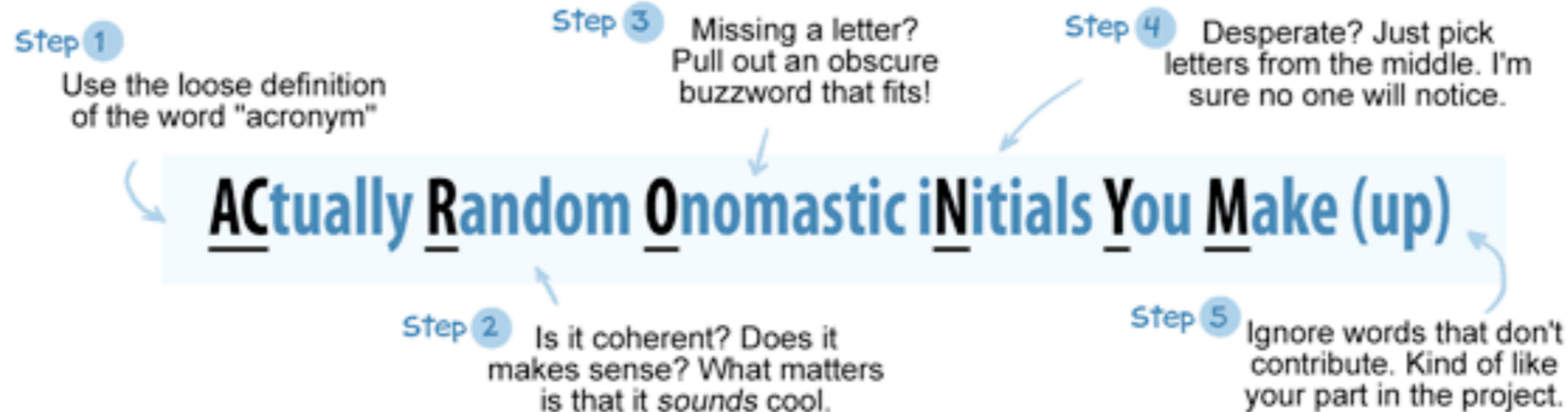
Technical Specifications

Group	Title	Most stable	In progress	Version history																
App	Simple Application Messaging Protocol	1.10		1.10	1.00															
DAL	Simple Cone Search	1.03		1.03	1.02	1.01	1.00													
	Simple Image Access	1.01		1.01	1.00															
	Simple Spectral Access	1.04		1.04	1.03	1.02	1.01	1.01	1.00											
DaM	Space-Time Coordinate Metadata for the Virtual Observatory (STC)	1.33		1.33	1.31	1.30	1.21	1.20	1.10	1.00										
	Data Model for Astronomical DataSet Characterisation	1.13		1.13	1.12	1.12	1.11	1.10	1.00											
	IVOA Spectral Data Model	1.03		1.03	1.02	1.01	1.01	1.01	1.00											
GWS	IVOA Single-Sign-On Profile: Authentication Mechanisms	1.01		1.01	1.01	1.00	1.00													
	VOSpace service specification	1.02	1.14 RFC	1.14	1.13	1.12	1.12	1.11	1.10	1.02	1.02	1.01	1.00	1.00						
	IVOA Credential Delegation Protocol	1.01	RFC	1.01	1.01	1.00														
	IVOA support interfaces	1.00		1.00																
	IVOA Web Service Basic Profile	1.00		1.00																
ReR	IVOA Identifiers	1.12		1.12	1.11	1.10	1.10	1.10	1.00											
	IVOA Registry Interfaces	1.01	RFC	1.01	1.00															
	Resource Metadata for the Virtual Observatory	1.12		1.12	1.12	1.10	1.10	1.01	1.01	1.00	1.00									
	VOResource: an XML Encoding Schema for Resource Metadata	1.03		1.03	1.02	1.02	1.01	1.00												
Semantics	An IVOA standard for Unified Content Descriptors	1.10		1.10	1.10	1.06	1.05	1.03												
	UCD1+ Controlled Vocabulary	1.23		1.23	1.22	1.21	1.20	1.20	1.11	1.11	1.10	1.02	1.00							
	Maintenance of the list of UCD words	1.20		1.20	1.20	1.10	1.00													
Vocabularies in the Virtual Observatory		1.16	RFC	1.16	1.15	1.13	1.00													
		1.00	1.10 RFC	1.10	1.10	1.00	1.00													
SDP	IVOA Document Standards	1.00		1.00																
VOE	Sky Event Reporting Metadata (VOEvent)	1.11		1.11	1.11	1.10	1.01													
VQL	IVOA Astronomical Data Query Language	2.00		2.00	2.00	2.00	1.01	1.00												
	IVOA SkyNode Interface	1.01		1.01	1.00															
VOT	VOTable Format Specification	1.10	1.20	1.20	1.10	1.00														

Maturity level: ■ Recommendation ■ Proposed Recommendation ■ Working Draft

**RADAMS: Radio Astronomy
Data Model for Single-dish
radio telescopes**

Clever Acronyms: the Holy Grail of Academia



Types of Acronyms:

- | | | | |
|----------------------------------------------------------------------------------------------------|---|----------------------------------------------|---------------------------------------------------------|
| - Folksy Names: a cheery name will distract people from the fact your project cost millions | → | A.L.I.C.E.,
B.O.B.,
D.A.V.E. ✓ | A.D.O.L.F.,
Z.I.P.P.O.,
S.I.G.M.U.N.D. ✗ |
| - Aggressive verb/predatory animal: a requirement for getting military funding | → | K.I.L.L.,
S.H.A.R.K.,
W.O.L.F. ✓ | O.B.L.I.T.E.R.A.T.E. (too many words!),
B.U.N.N.Y. ✗ |
| - Greek names: nothing says "Sci-Fi" like a good greek name | → | O.M.E.G.A.,
A.L.P.H.A.,
S.I.R.I.U.S. ✓ | T.O.G.A.,
P.I.T.A.,
T.Z.A.T.Z.I.K.I. ✗ |

Remember:

Acronyms cleverly reveal one's nimble youthful mastery abbreviating construed rigidly opted nomenclature, yielding monetary awards contracting research overtures not yet manifested!

Bonus points: make your acronym recursive!

recursive
recursive
recursive

WWW.PHDCOMICS.COM

Initial RADAMS sources

Data Model for Observation

— McDowell, Bonnarel et al., IVOA Data Model WG Internal Draft

Data Model for Astronomical Dataset Characterisation

— McDowell, Bonnarel et al., IVOA Data Model WG Note

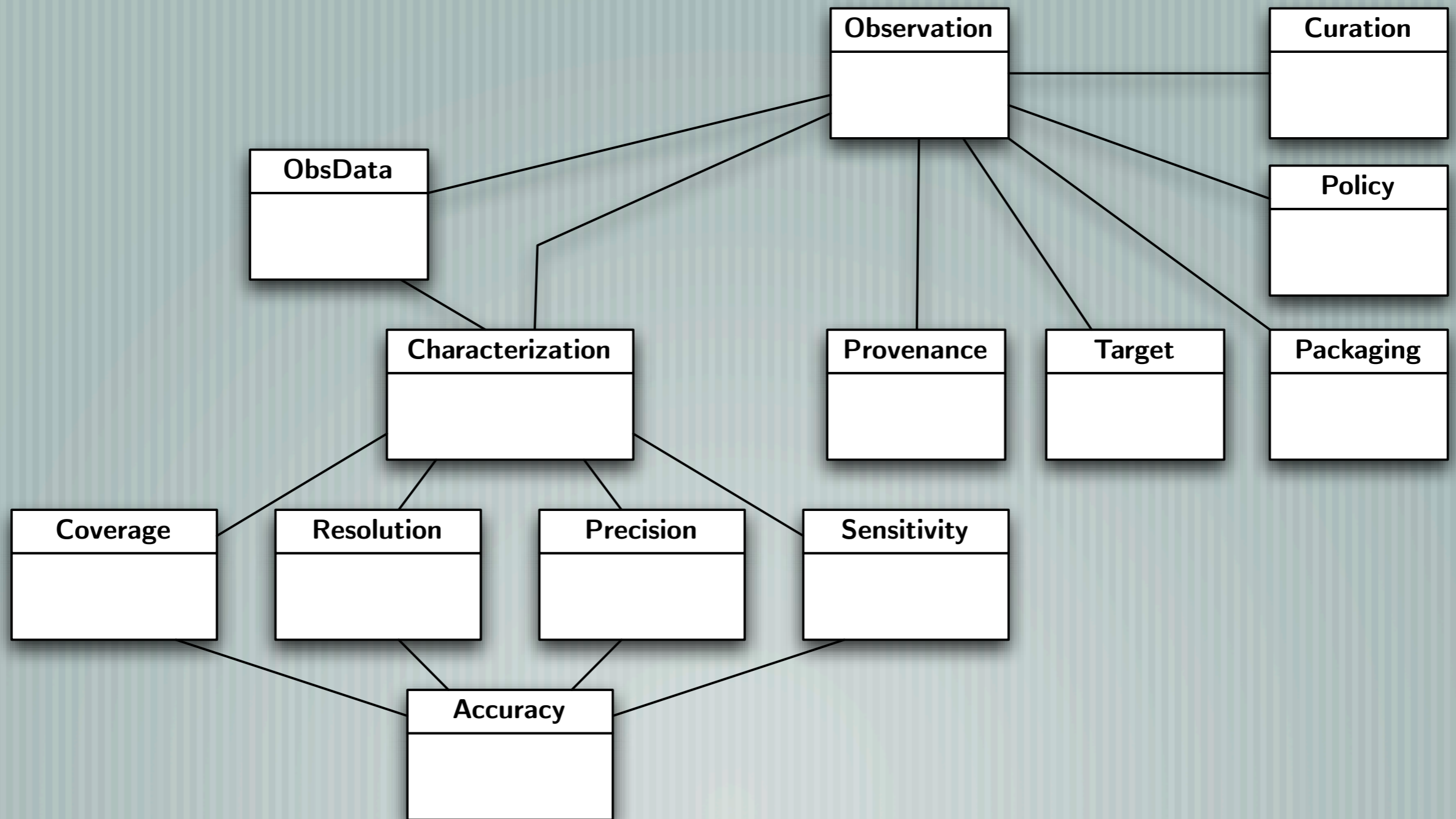
IVOA Spectral Data Model

— McDowell, Tody et al., IVOA Data Model WG Working Draft

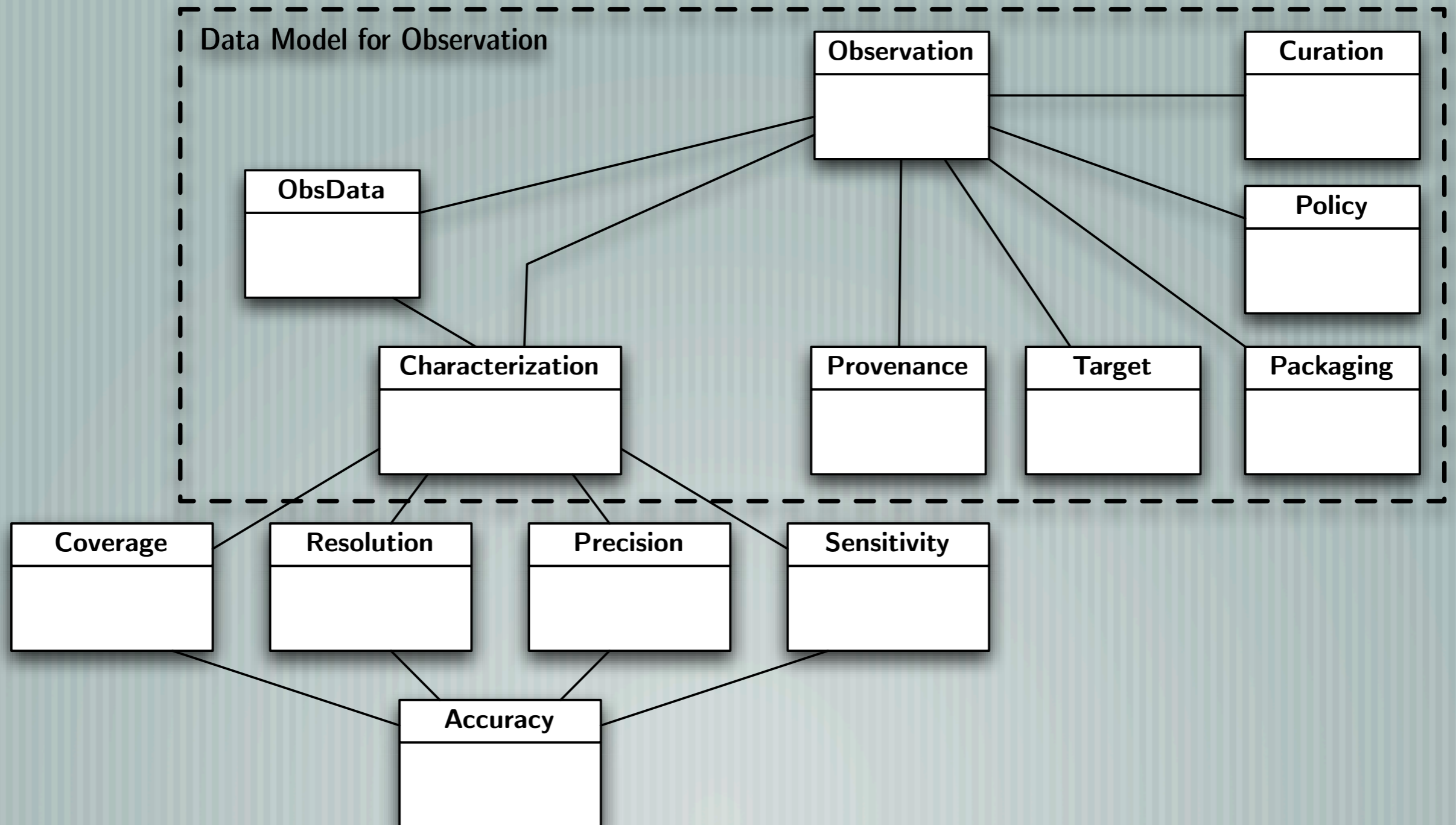
IVOA Data Model for Raw Radio Telescope Data

— Lamb and Power, IVOA Radio IG Note

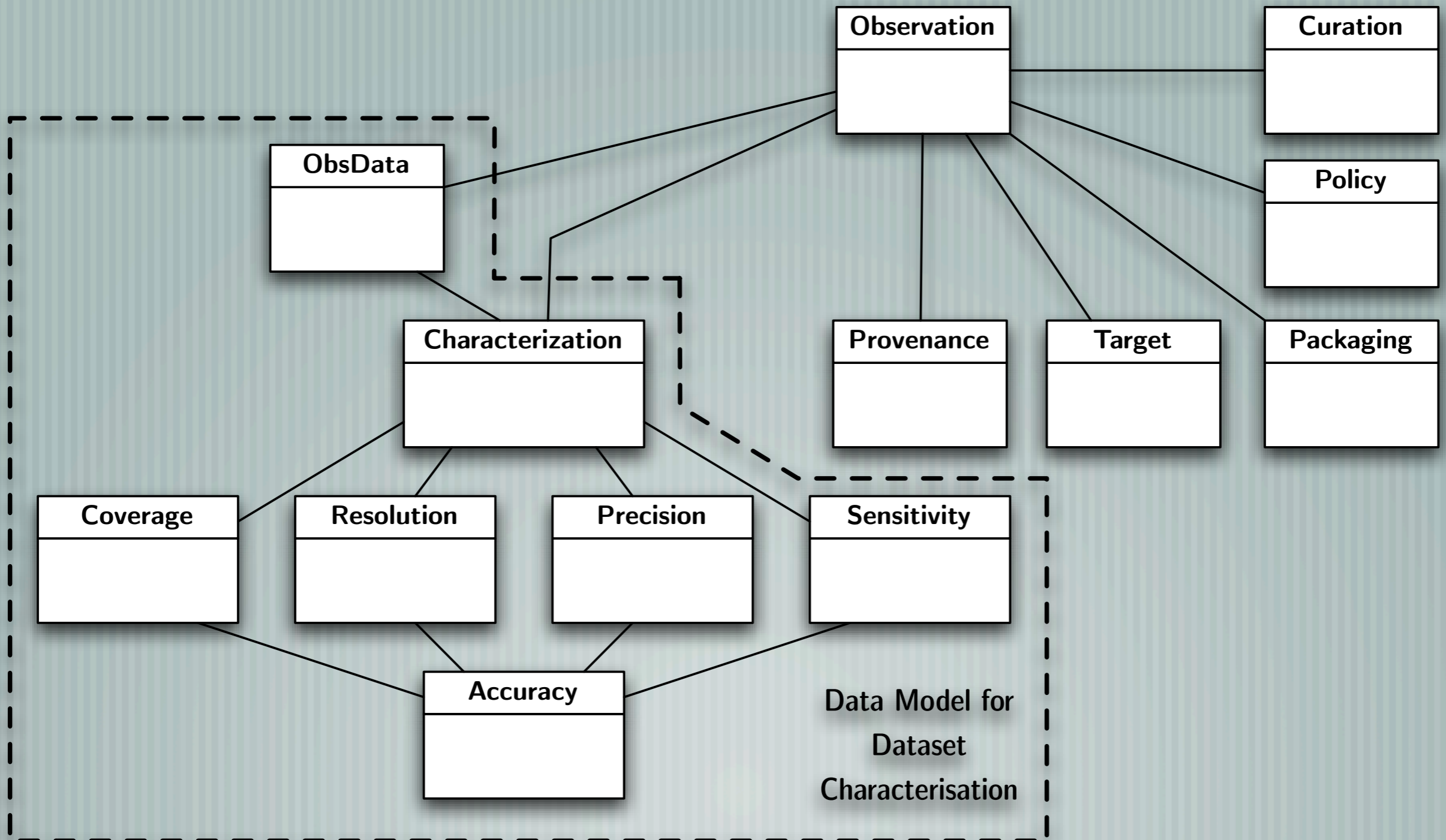
RADAMS Structure



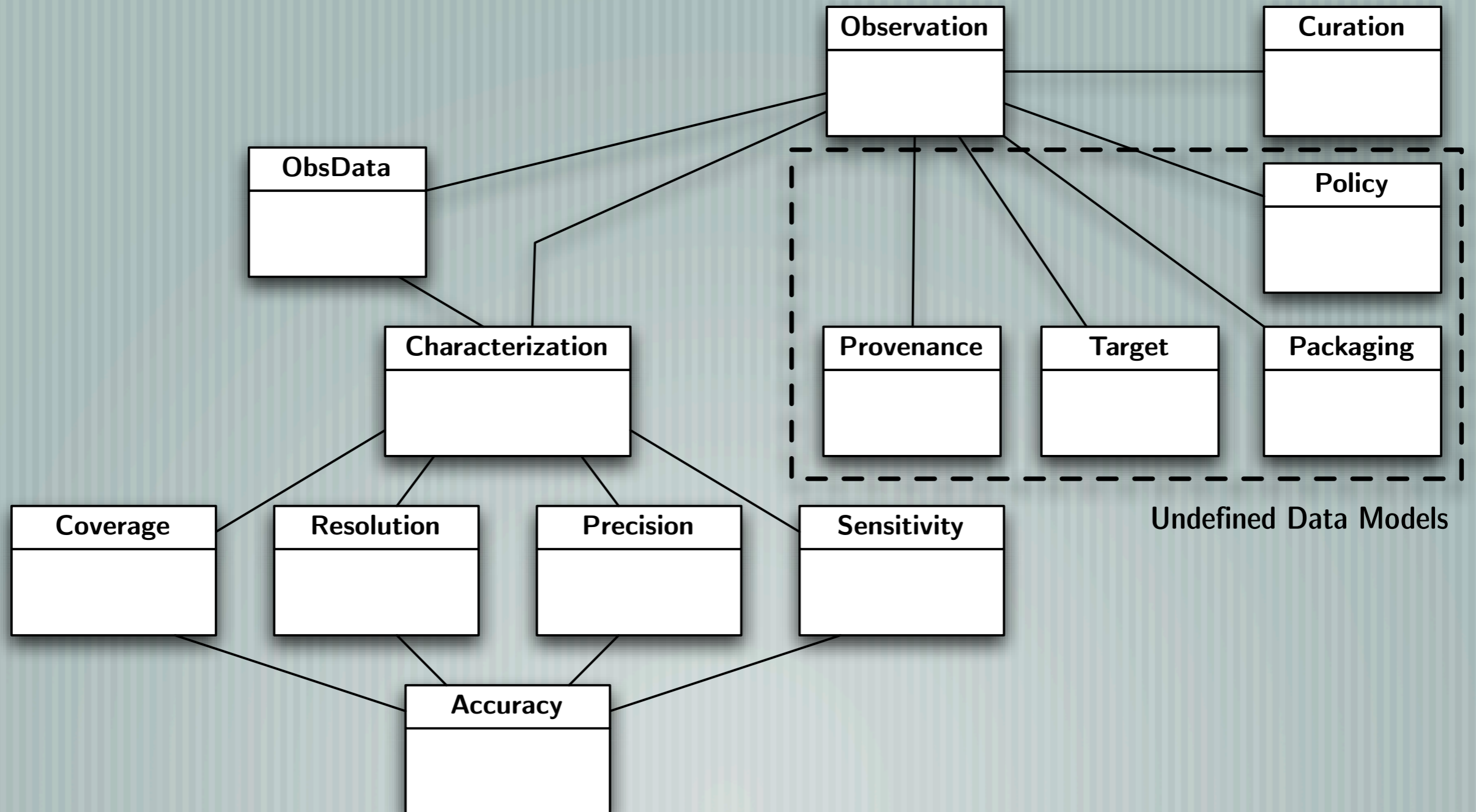
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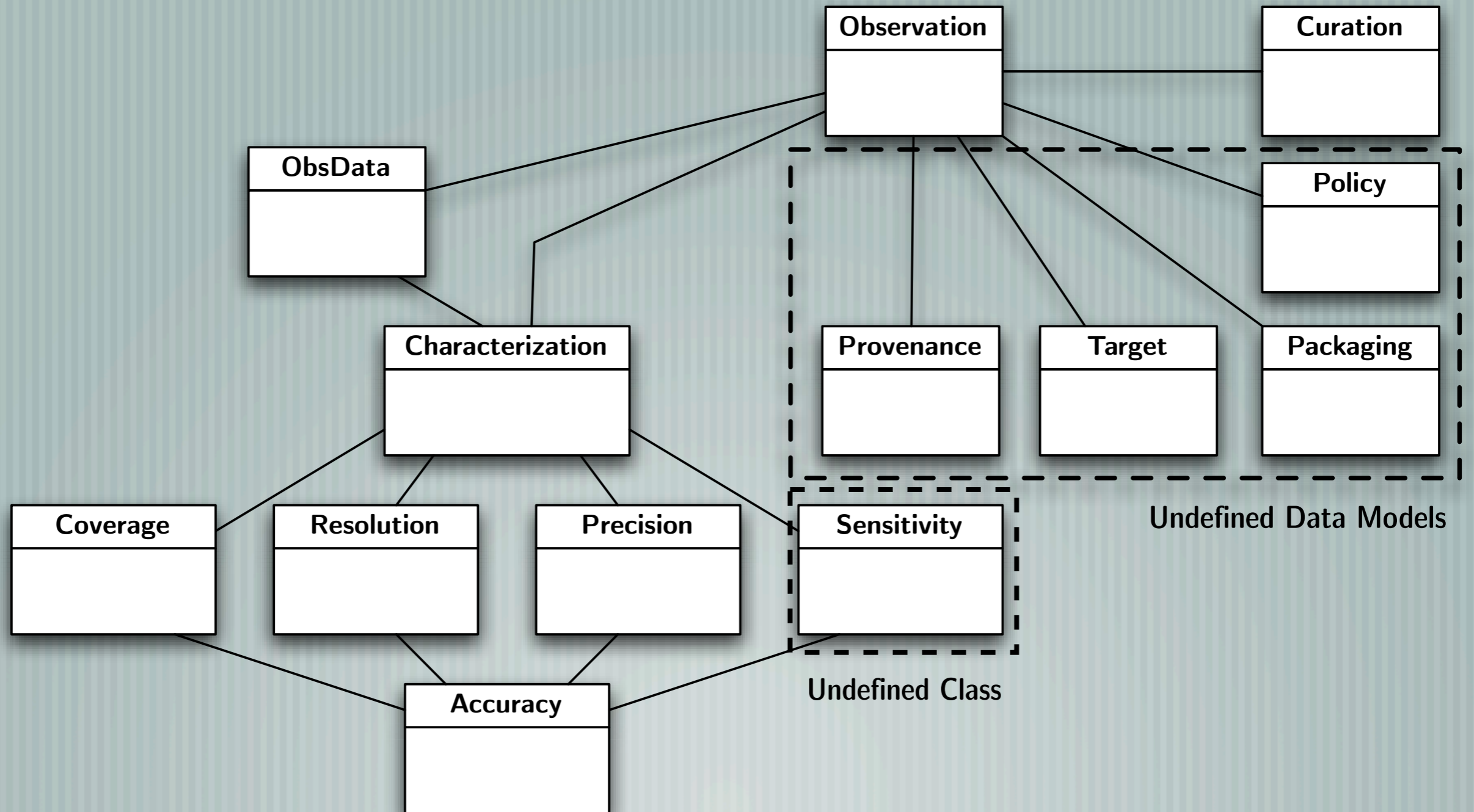
RADAMS Structure



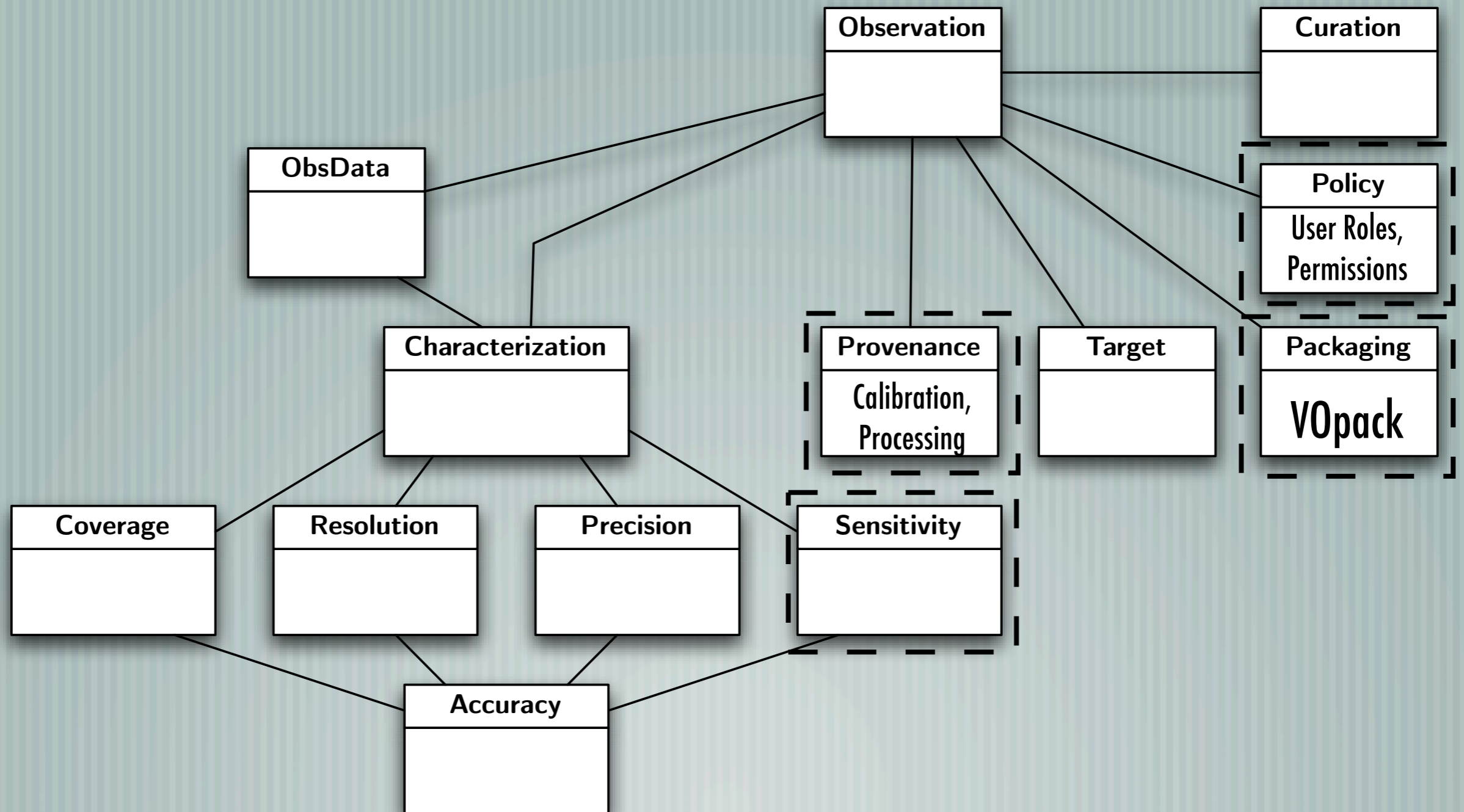
RADAMS Structure



RADAMS Structure



RADAMS Main Contribution



RADAMS Implementations

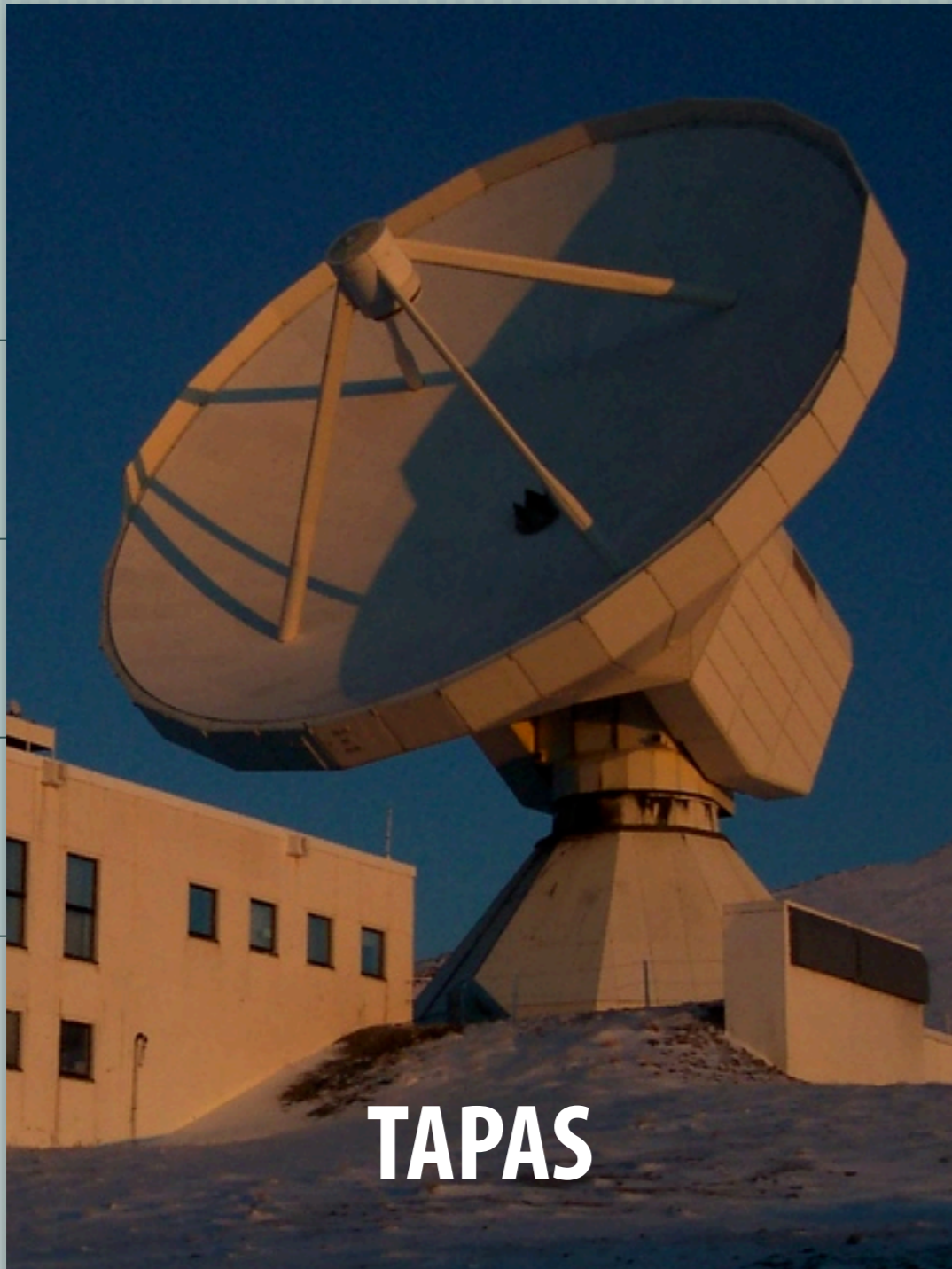
— [DSS-63 antenna archive

— [IRAM 30m public archive

— [MOVDIR tool for MASSA, MADCUBA

— [Plus, contributing RADAMS to IVOA Data Modeling WG

RADAMS Implementations



e
MADCO
MS to

Conclusions

Conclusions

- [Data Models are an important part of interoperability

- Not everything can be included in DMs, but yet...

- Semantics discovery provide flexibility, interoperability

- [Many DMs in place

- Many more being refined (CharDM), worked on (Obs)

Conclusions

- [RADAMS, first VO-Compatible DM specific for Radio Astronomy

- Deals with radio specific part of radio observations

- Provides completions for Observations DM

- Provides a footprint for bringing ALMA data into VO

- [Most important future dev: DM for 3D/4D data

- Will be working with ALMA Archive team on that

Thank you!