



International Virtual Observatory Alliance

The Standards Organization for Data Interoperability in Astronomy

G. Fabbiano

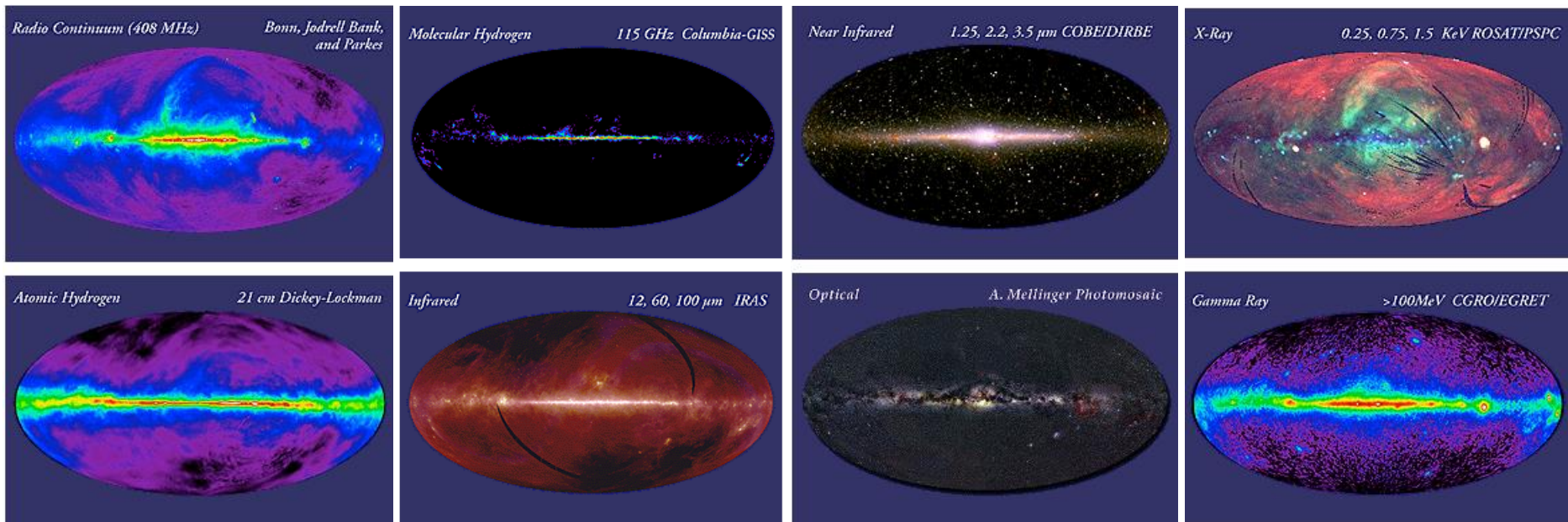
Senior Astrophysicist, Smithsonian Astrophysical Observatory

Head, Data Systems Division, Chandra X-ray Center

Chair of International Virtual Observatory Alliance Executive Committee


What is the Virtual Observatory?

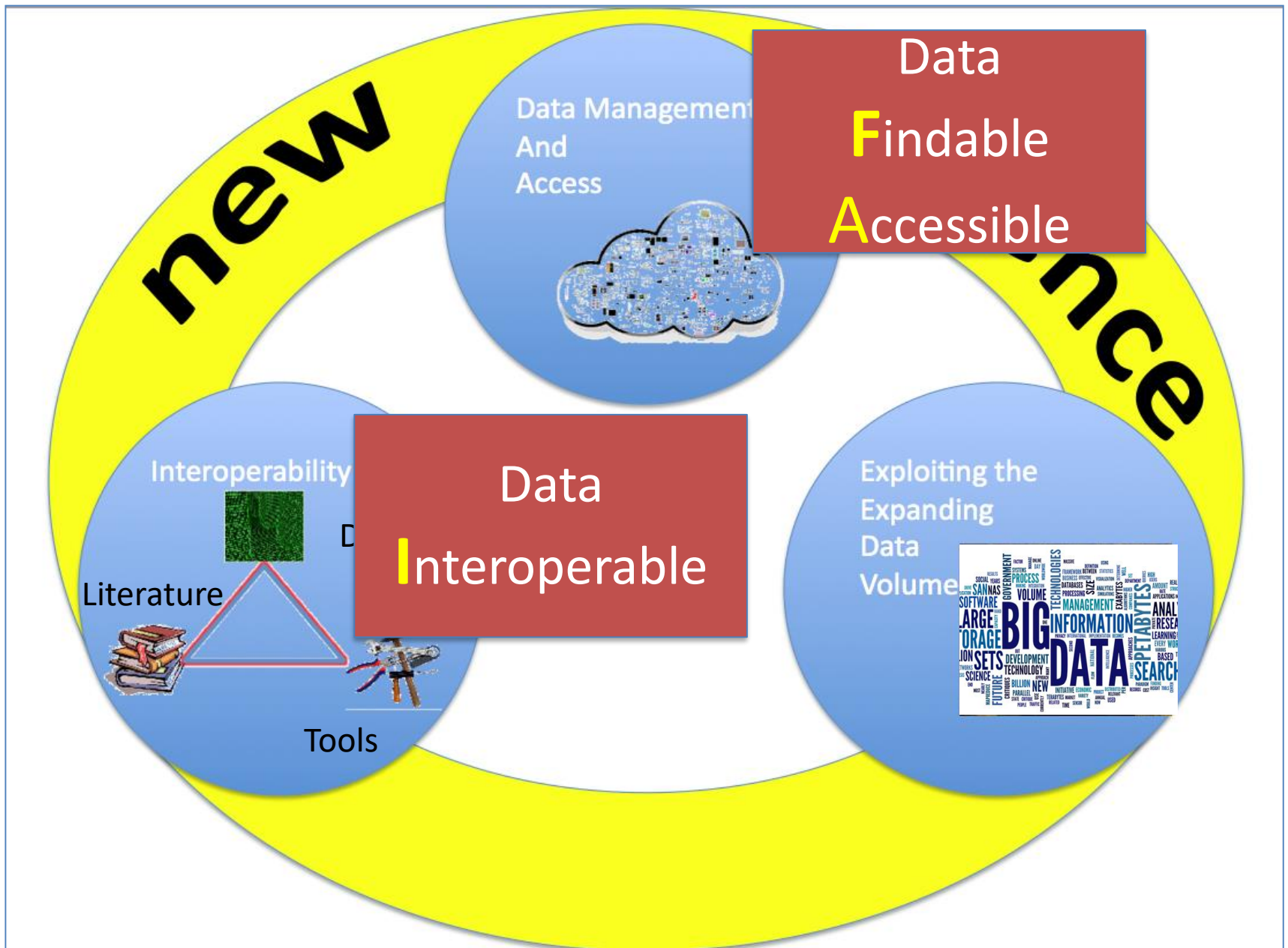
A multi-wavelength digital sky that can be searched, visualized, and analyzed in new and innovative ways

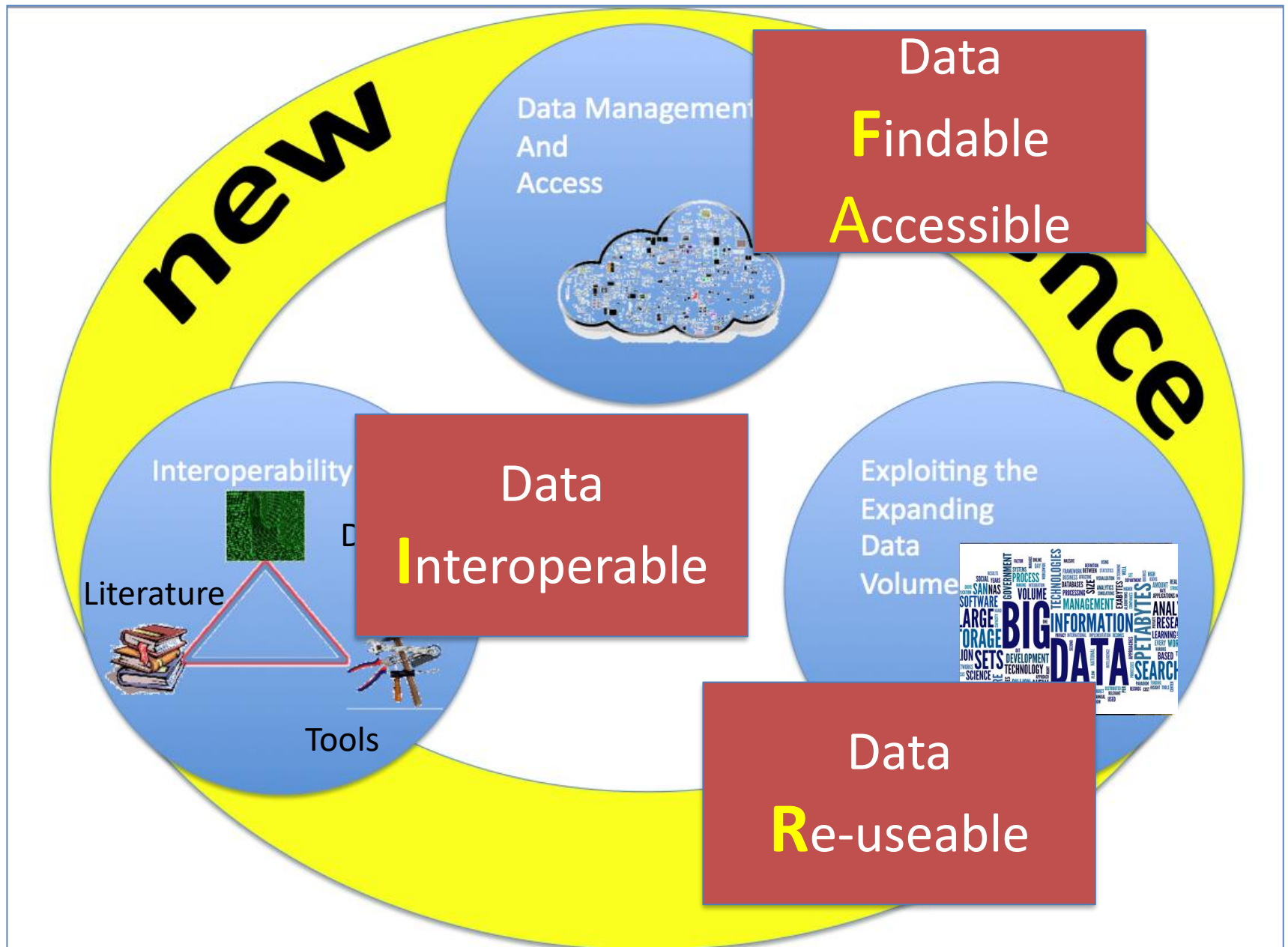


What is the Virtual Observatory?

The VO is the latest stage of good data practices in astronomy

- 
- Each data center / archive with different file structure, metadata, table organization
 - The data is there, but it takes work to access it, especially if several data sets are used together
 - FITS provided a first standardization
 - The Virtual Observatory is the natural progression towards interoperability of data, services and tools









The VO is a Framework

- For data centers to provide co-operating data services
- For software providers to offer a variety of compatible analysis and visualization tools and user interfaces



- Support interdisciplinary (multi-wavelength) and collaborative research in astronomy
- Exploit the full power of growing and emerging data sets
- Provide powerful and unique data and tools for education and public outreach

The VO is a Framework

- For data centers to provide co-ordinating data services
- For software providers to offer a variety of compatible analysis and interfaces

A large, multi-pointed orange starburst graphic with a 3D effect, centered on the slide. It contains the word "Standards !" in bold black text.

Standards !

- Support in collaborative environments
- Exploit the full power of growing and emerging data sets



IVOA Standards

At the core of the VO is a set of standards developed within the International Virtual Observatory Alliance (IVOA) to support good data management and interoperability

- Standardization of data and metadata for observed and simulated data
 - Data Model; Uniform Content Descriptors
- Standardization of data exchange methods
 - Data Access Layer; VO Query Language
- Standardization of lists and characteristics of available services
 - IVOA registry
- Standardization of application messaging protocol
 - SAMP
 - VO-enabled tools and services can interface seamlessly with VO-enabled archives worldwide



IVOA Today

www.ivoa.net

- Created in 2002, the International Virtual Observatory Alliance (IVOA) today has 21 member projects
- **The IVOA has no direct funding**
 - Affiliated projects seek funding from their national agencies





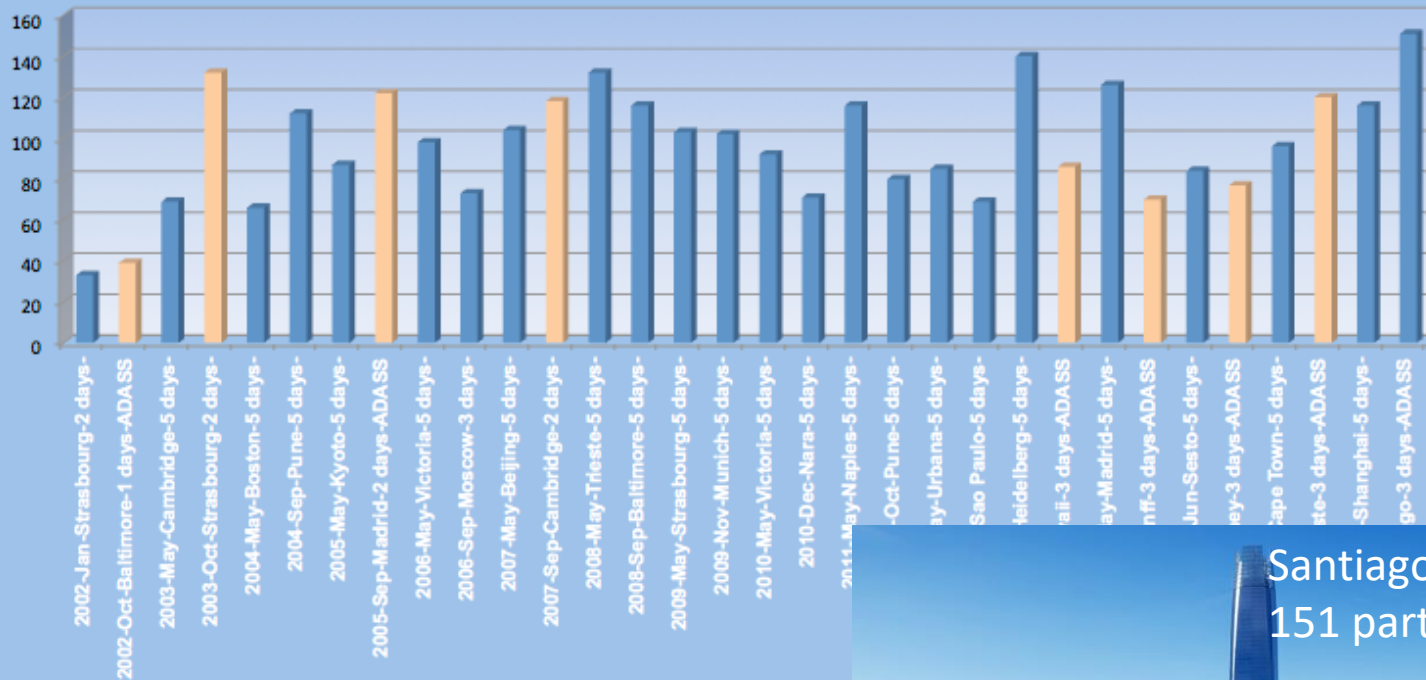


IVOA Today

www.ivoa.net

- 2 well attended interoperability working meetings per year

Number of Participants per IVOA Interoperability Meeting



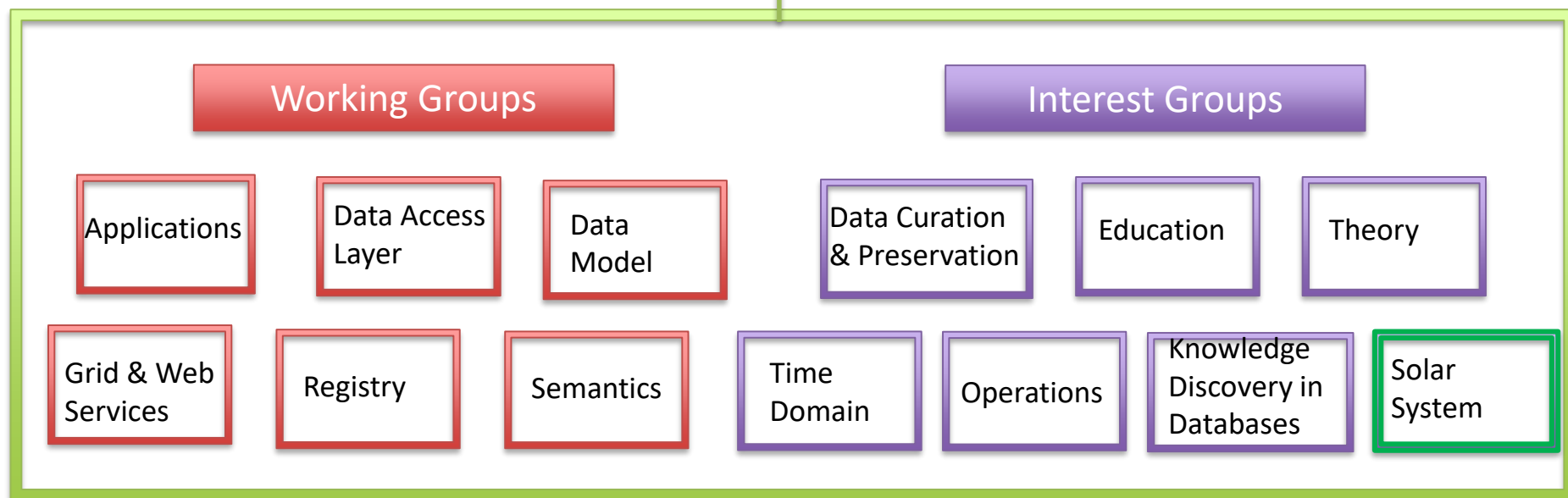
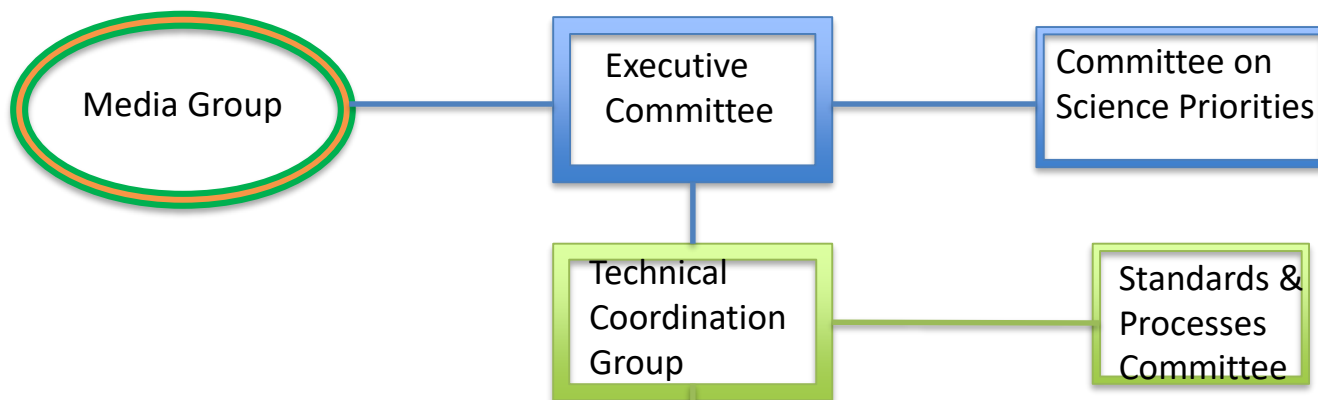
Nov. 2017

G. Fa





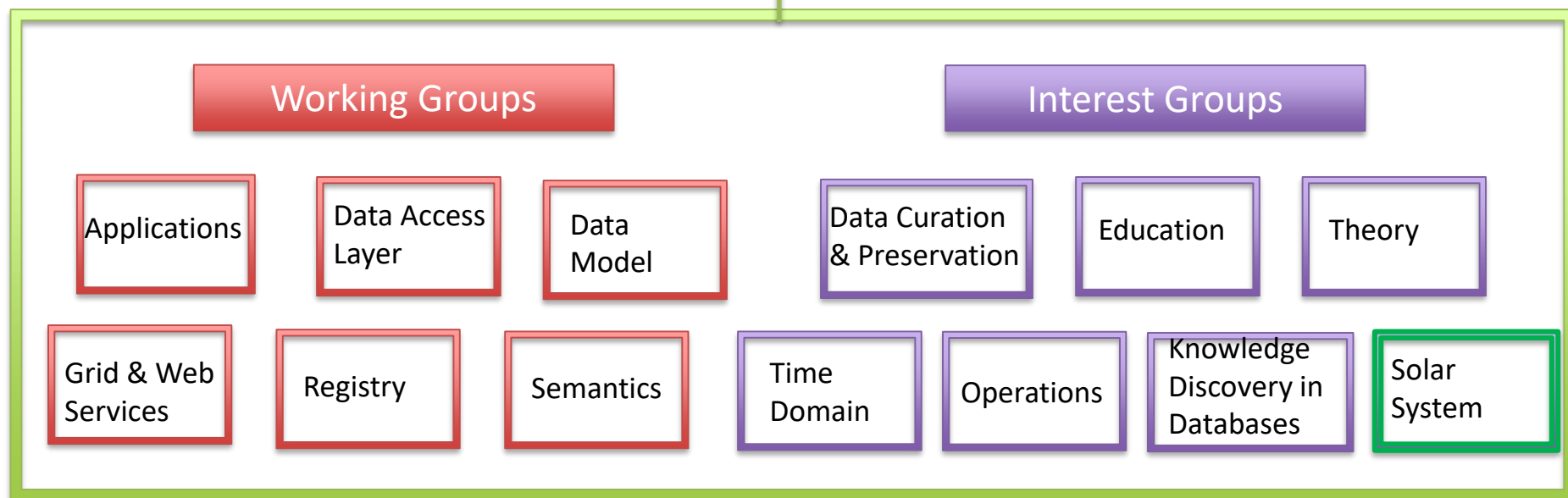
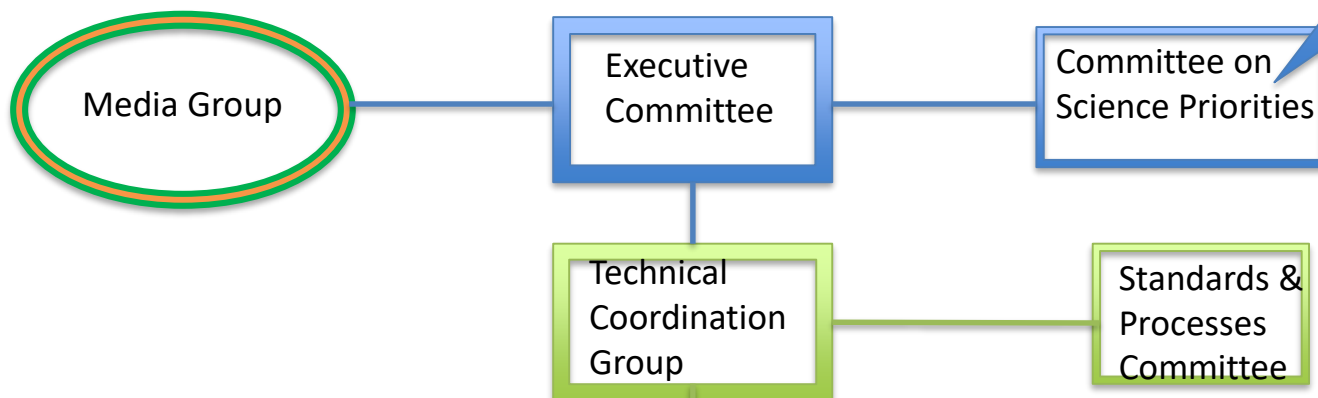
IVOA Organization Chart





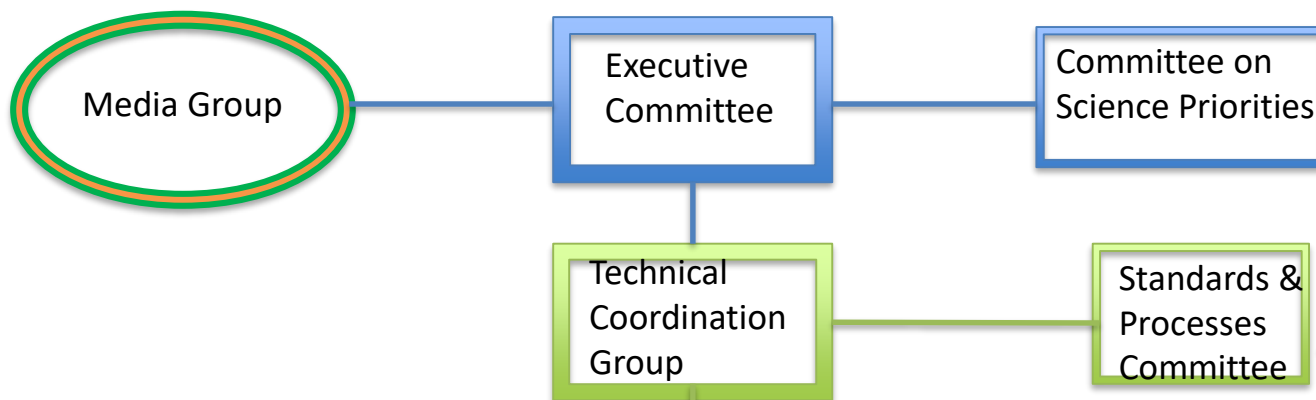
IVOA Organization Chart

Interface with
science
community

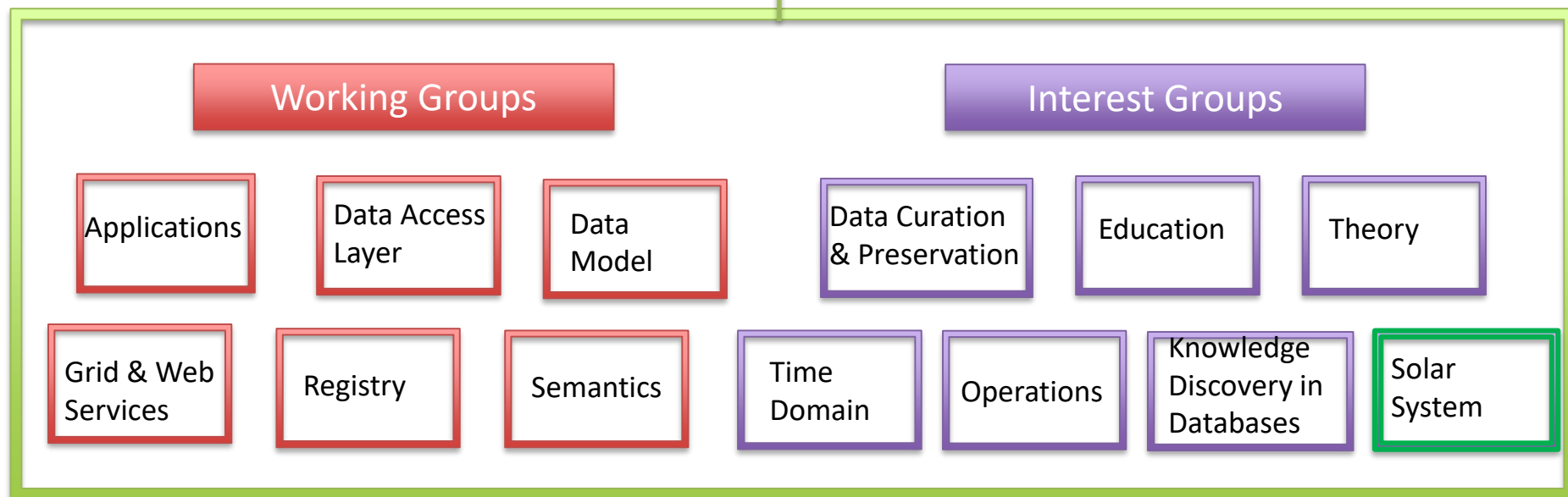




IVOA Organization Chart

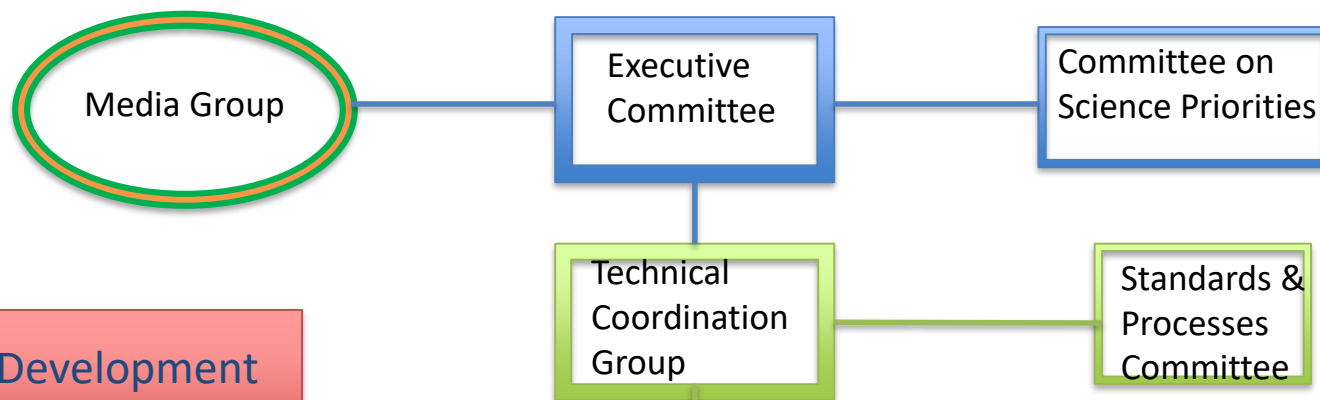


We need well-defined processes to make this international collaboration work effectively





IVOA Organization Chart



Standard Development

Working Groups

Interest Groups

Applications

Data Access
Layer

Data
Model

Data Curation
& Preservation

Education

Theory

Grid & Web
Services

Registry

Semantics

Time
Domain

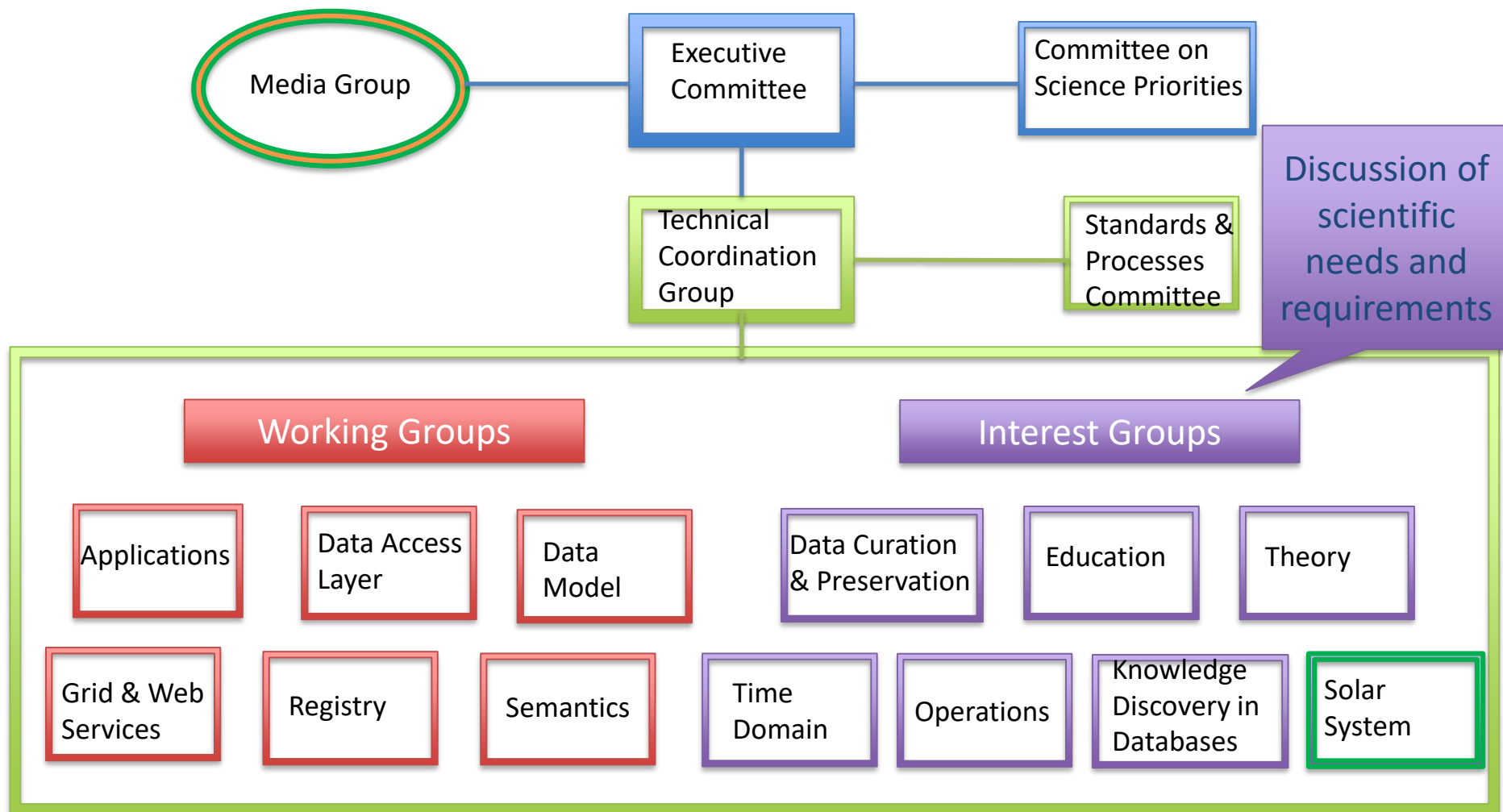
Operations

Knowledge
Discovery in
Databases

Solar
System



IVOA Organization Chart





IVOA Successes –Archives in the VO

- Major astronomical data collections accessible through the VO
 - CDS, CADC, MAST, IRSA, ESA, Chandra, ...

The screenshot displays the Virtual Observatory (VO) interface. At the top, there's a search bar with 'm31' entered. Below it, a table titled 'A List of Data Resources' lists various astronomical data collections. The table has columns for Actions, Short Name, Type, Title, Waveband, Records Found, FITS Images, and Other Images. The resources listed include HST Previews, CDA, CSC, SDSS SIAP, XMM-Newton SIAP, ASCC-2.5_Search, GALEX, hdap_siap, USNO-A2.0, USNO-SA2.0, XMM-Newton SIAP Service for Pointed Observation, ISO SIAP, TGCat SIA, HST_APPP, ELODIE, DSS ESO, and TGCat SCS. On the right side, there's a panel titled 'AstroView' showing a celestial image of Messier 031 with coordinates 00:43:21.069 +41:13:27.44 and RA DEC 00:42:44.350 +41:16:08.62.

Select a collection... and enter target:
All Virtual Observatory Collections m31
About Collections... Show Examples... Random Search

Upload Target List My Download Basket: 0 files User Manual/Help | Leave Feedback | About This Site

Home Page VO: m31 25 Total Rows 5.4% of resources searched

Filters

Keyword/Text Filter

Type

Waveband

Publisher

Subject

Actions	Short Name	Type	Title	Waveband	Records Found	FITS Images	Other Images
1	HST Previews		Hubble Space Telescope Preview Images	Optical	2000	1001	999
2	CDA		Chandra X-ray Observatory Data Archive	X-ray	1526	754	772
3	CSC		Chandra Source Catalog	X-ray	692	290	402
4	SDSS SIAP		Sloan Digital Sky Survey Images (Latest Release)	Optical	630	630	0
5	XMM-Newton SIAP		XMM-Newton SIAP Service for Slew Observations		462	462	0
6	ASCC-2.5_Search		Simple cone search for the All Sky Compiled Catalogue (...)	Optical	444	0	0
7	GALEX		Galaxy Evolution Explorer	UV	204	128	76
8	hdap_siap		HDAP -- Heidelberg Digitized Astronomical Plates	Optical	132	132	0
9	USNO-A2.0		USNO-A2.0	Optical	102	0	0
10	USNO-SA2.0		USNO-SA2.0	Optical	102	0	0
11	XMM-Newton SIAP		XMM-Newton SIAP Service for Pointed Observation		78	78	0
12	ISO SIAP		The ISO Data Archive InterOperability System		54	54	0
13	TGCat SIA		Chandra Transmission Grating Catalog and Archive, Sim...	X-ray	27	9	18
14	HST_APPP		HST Archival Pure Parallels Project	Optical	22	22	0
15	ELODIE		ELODIE archive		20	0	0
16	DSS ESO		Digitized Sky Survey		16	8	8
17	DSS ESO		Digitized Sky Survey	Infrared, Opti...	16	8	8
18	TGCat SCS		Chandra Transmission Grating Catalog and Archive, Sim...	X-ray	9	0	0

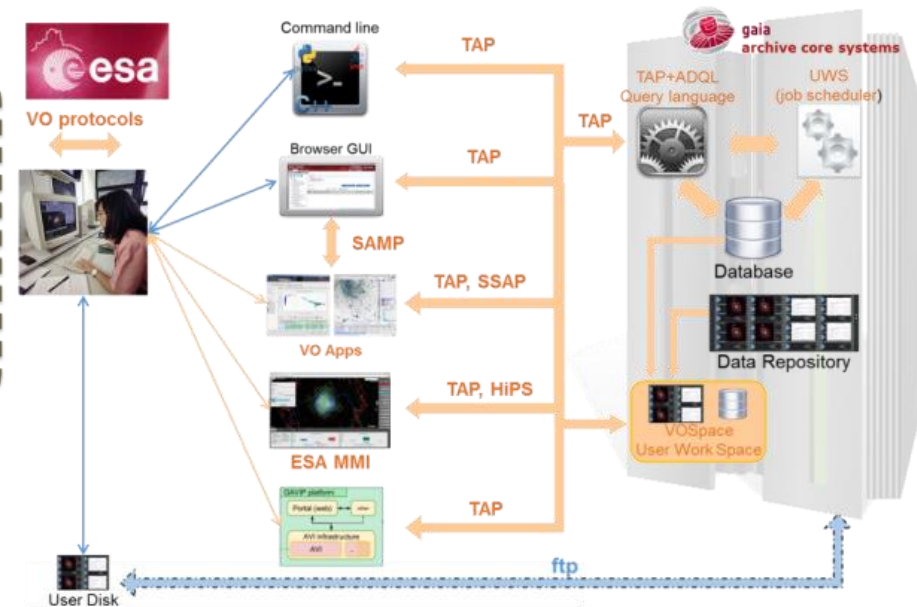
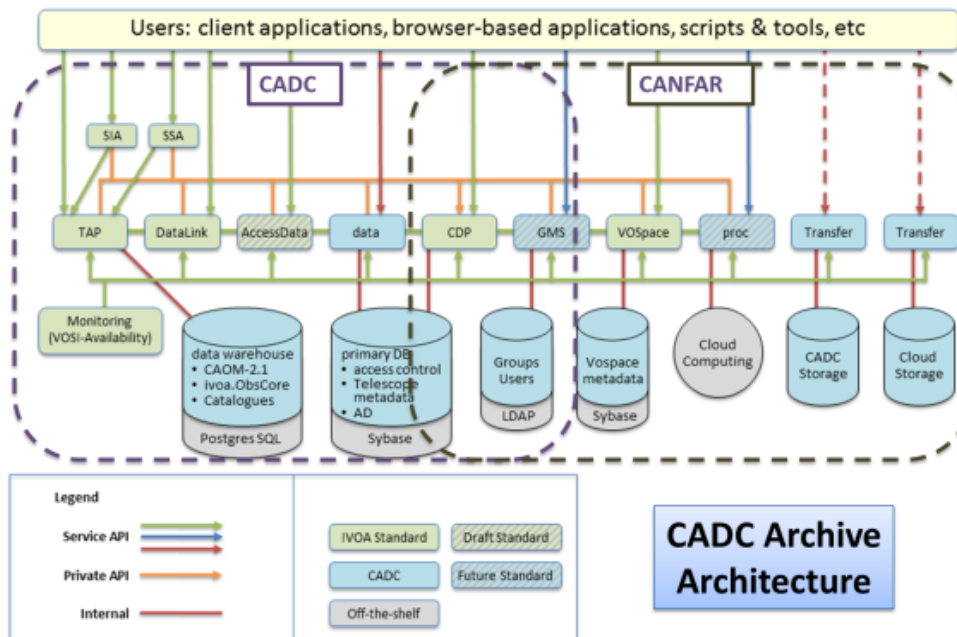
AstroView

00:43:21.069 +41:13:27.44
00:42:44.350 +41:16:08.62
RA DEC
hhmmss/deg



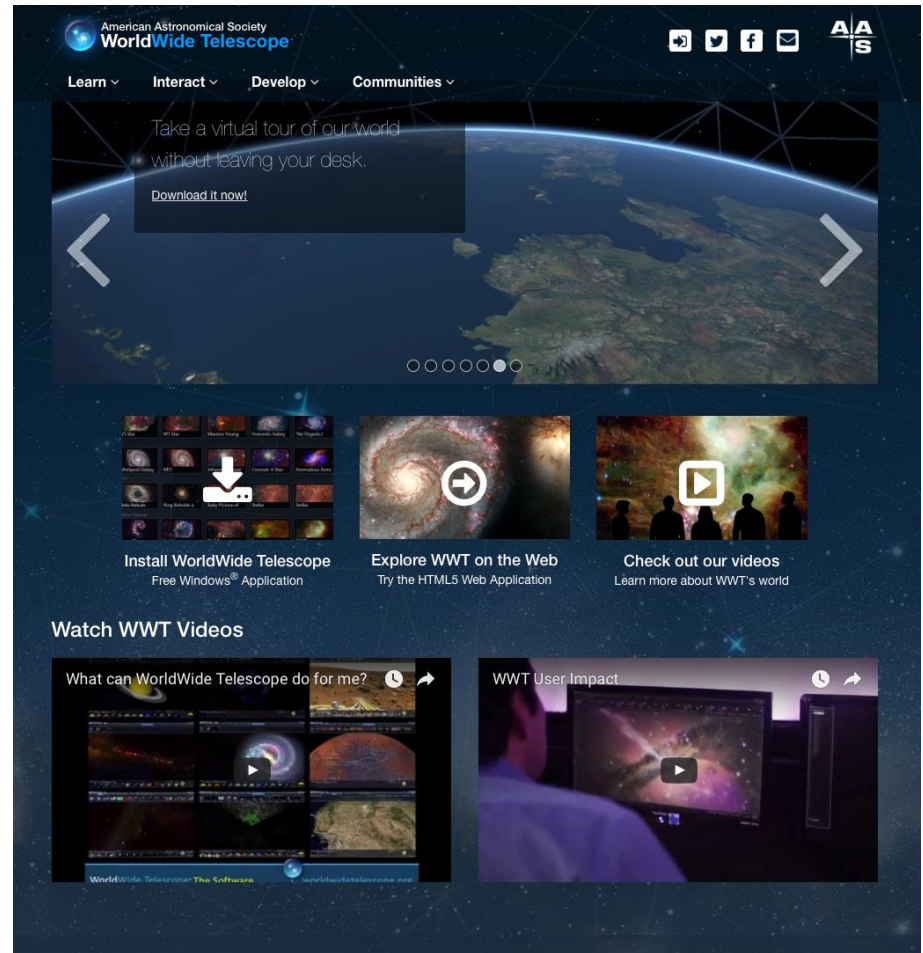
IVOA Successes – VO in Data Centers

- VO-ready infrastructure built-in astronomical data centers
 - CADC, Gaia, Euclid, ...
 - Data (file & database) access and User Work Space (VOspace)



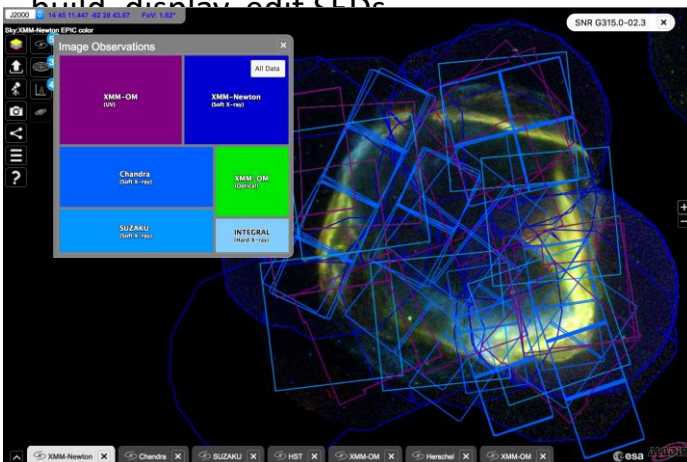
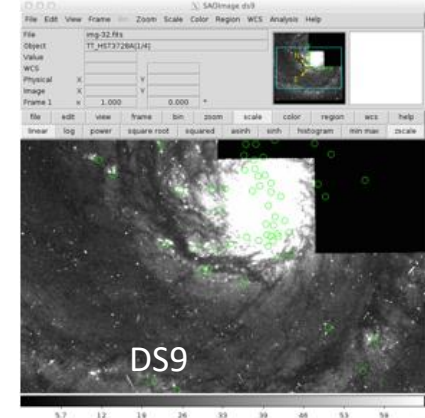
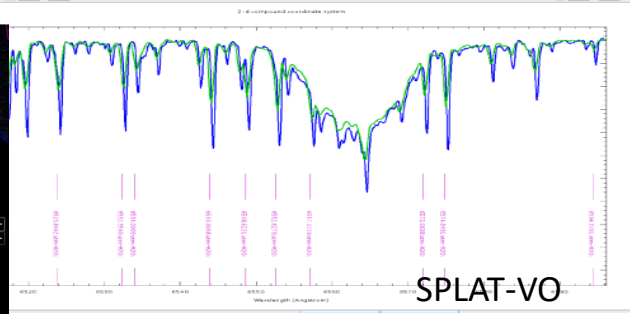
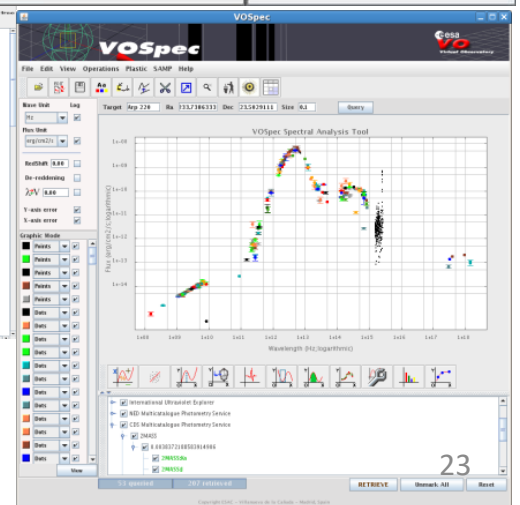
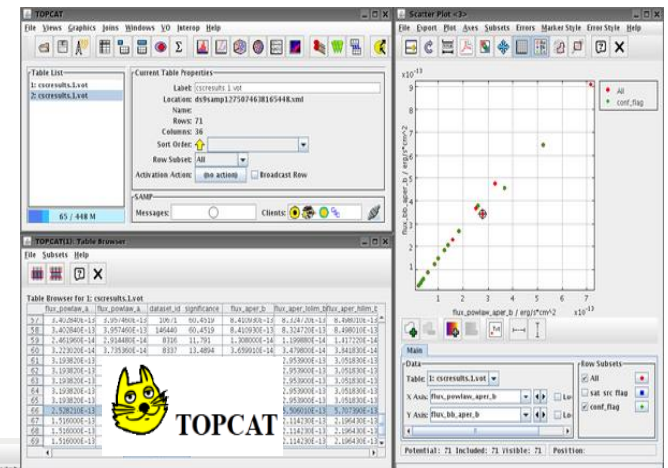
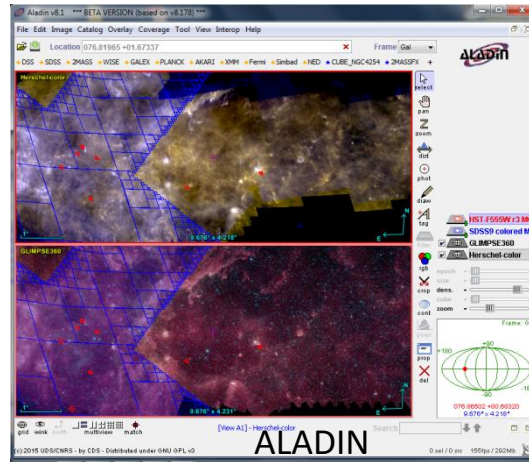
IVOA compliant 3rd-party applications

- VO-inspired and VO-compliant
 - WorldWide Telescope (Microsoft)
 - Now under American Astronomical Society management
 - Used for education and outreach in the USA and other countries (e.g., China)

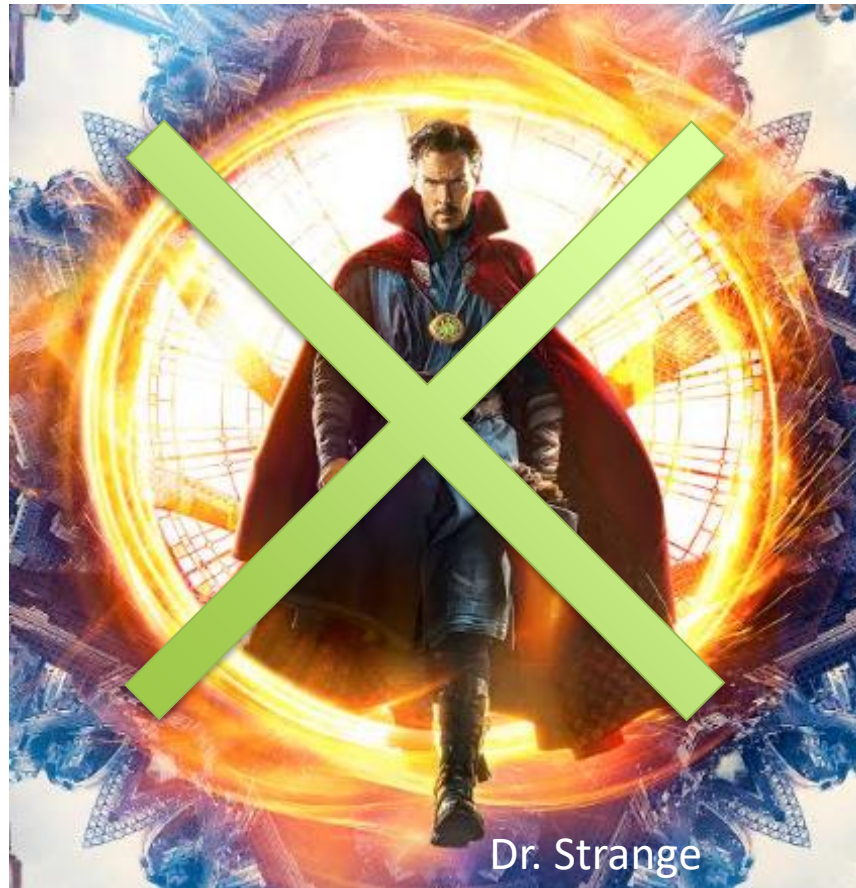


VO interoperable applications

- Topcat, Aladin, VOSpec, SPLAT-VO, Iris, DS9, ESAsky



The VO **is not** a Killer Application



Dr. Strange

The VO is an Evolving Ecosystem

IVOA defines VO “ecosystem” and interoperability standards

- Astronomy projects and data services build VO services and VO applications
- VO registries, Archive interfaces and VO-enabled software offer Entry Points to VO resources, Visualization, Analysis
- Increase in the software and technological literacy of the average astronomer is helping in VO uptake