
# International Virtual Observatory Alliance

## The Standards Organization for Data Interoperability in Astronomy

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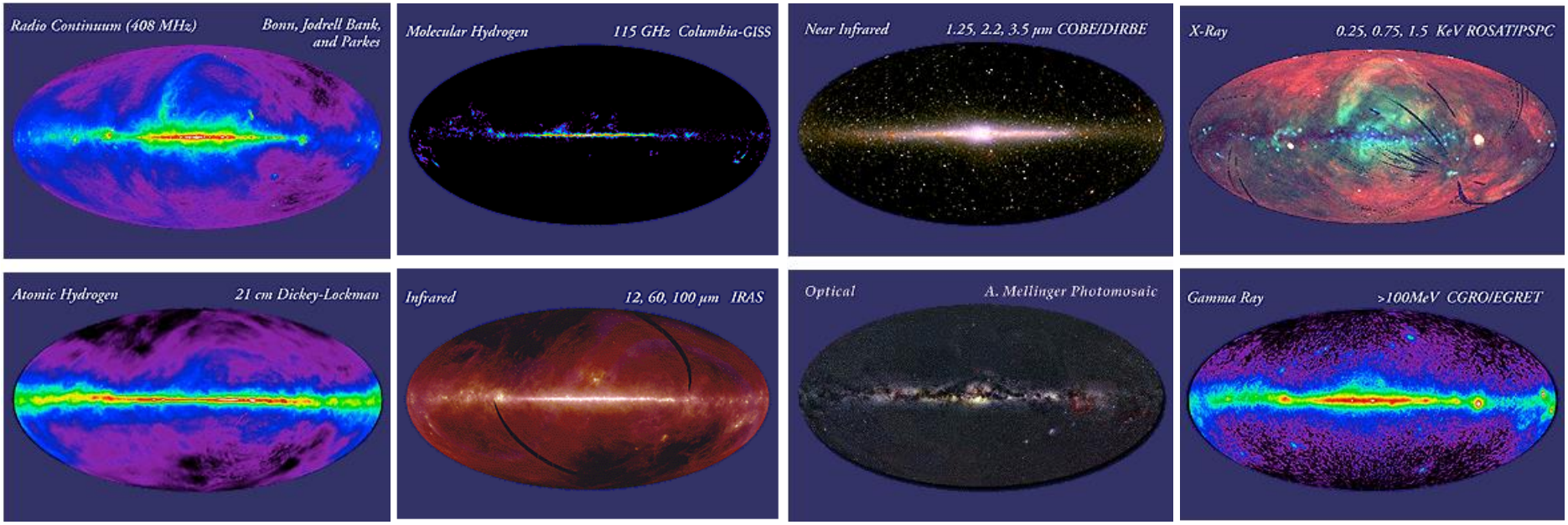
*Chair of International Virtual Observatory Alliance Executive Committee*

# What is the Virtual Observatory?

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



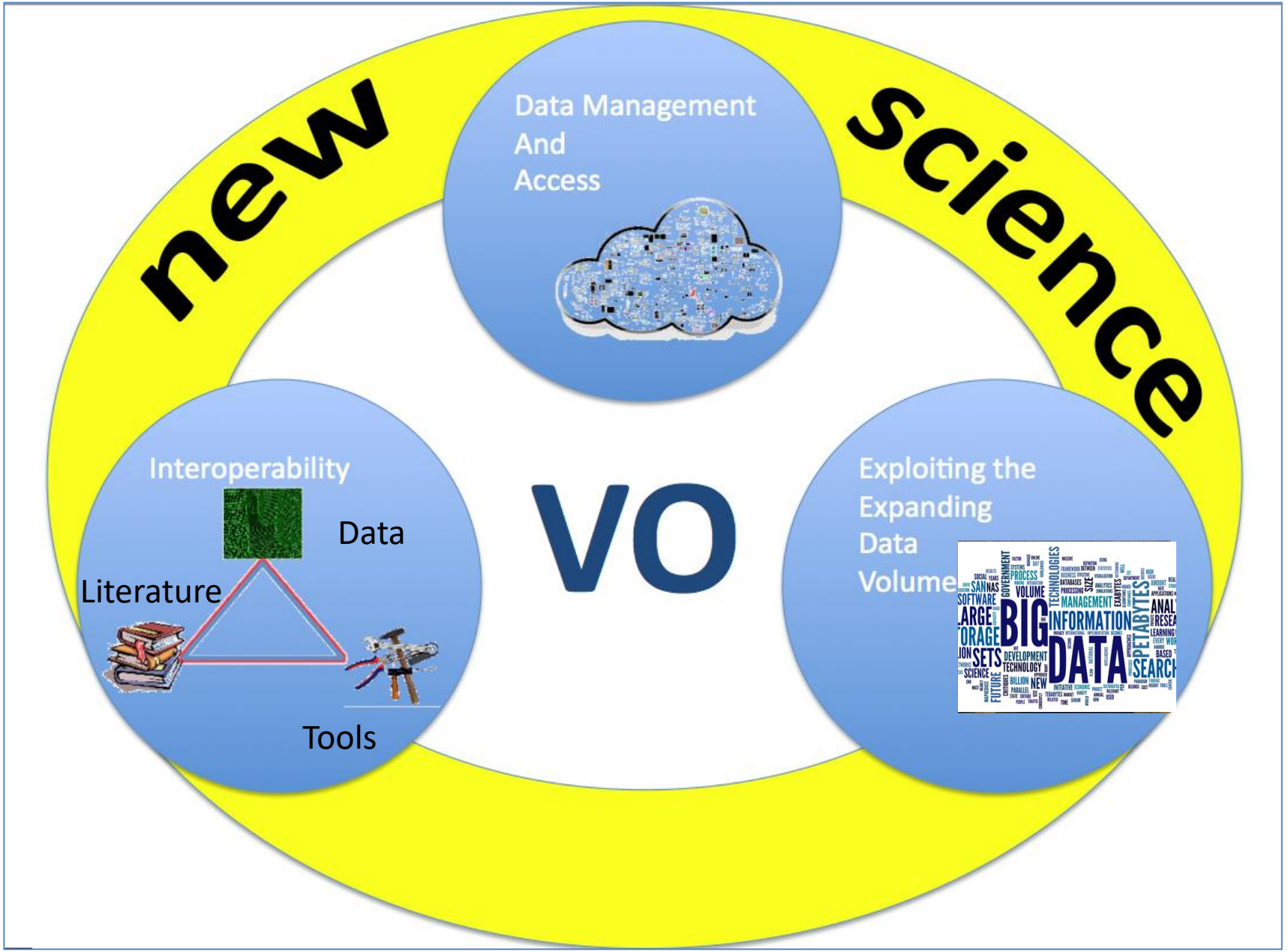
# What is the Virtual Observatory?

**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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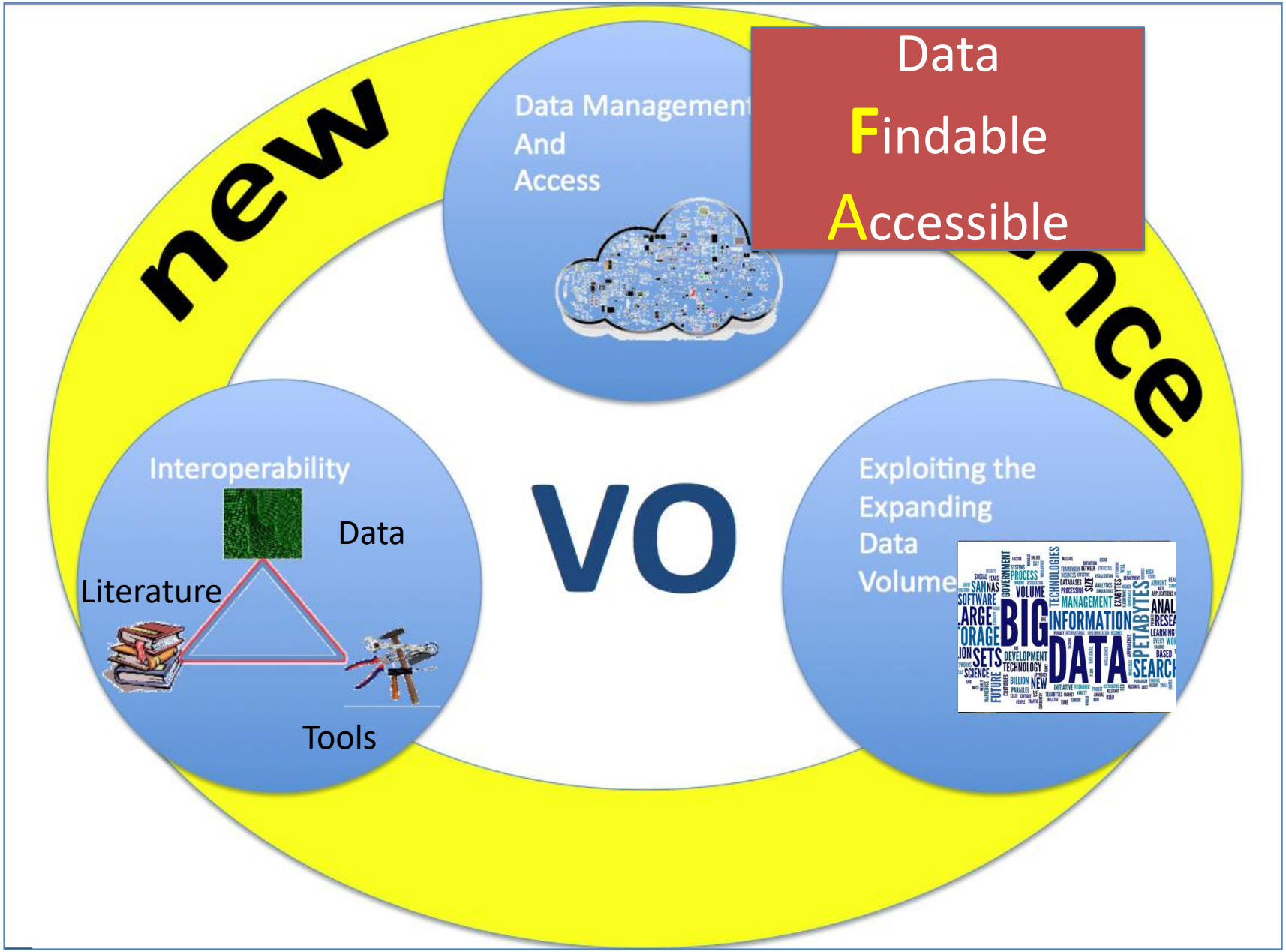
VO
Exploiting the
Expanding
Data
Volume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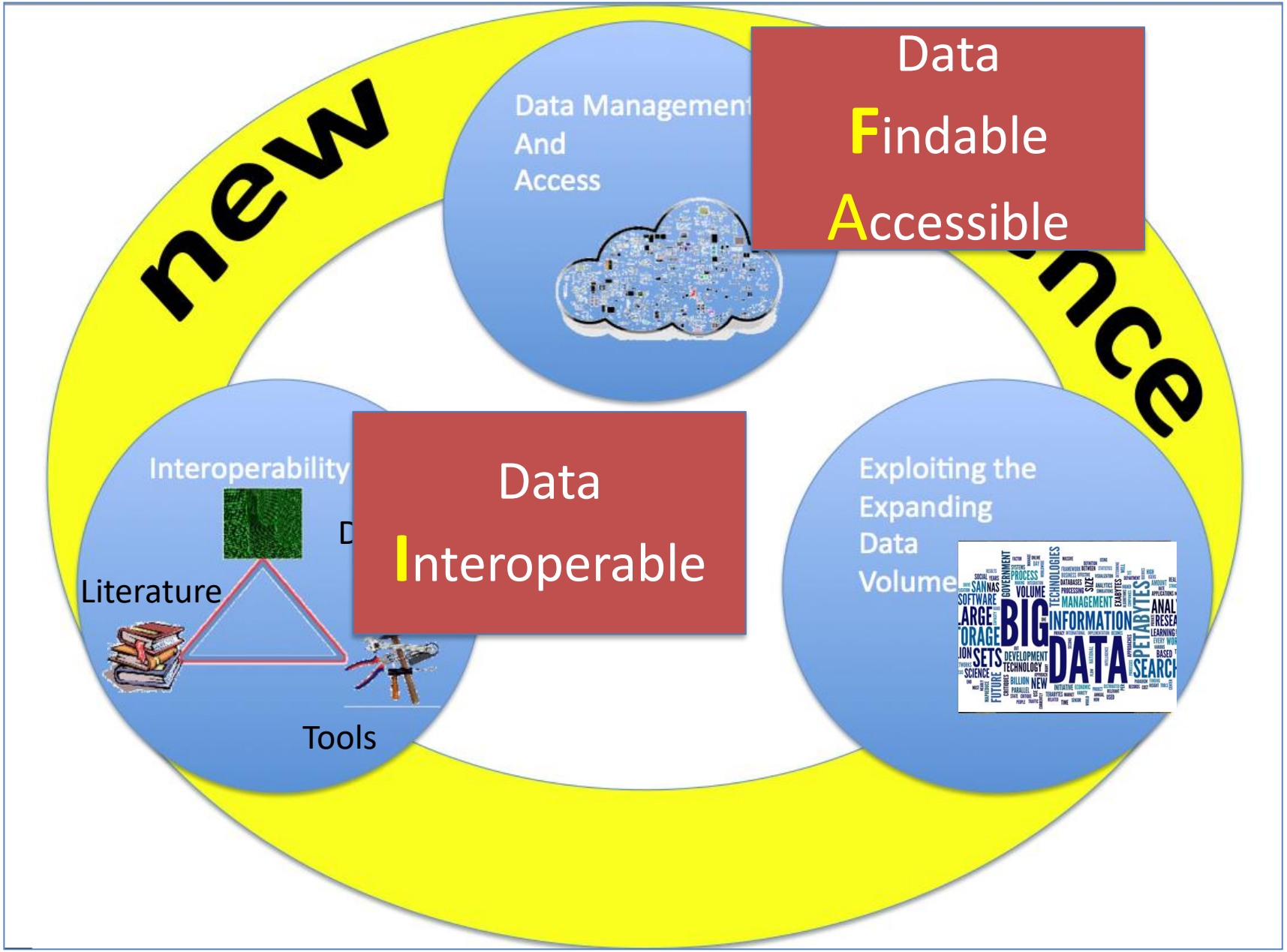
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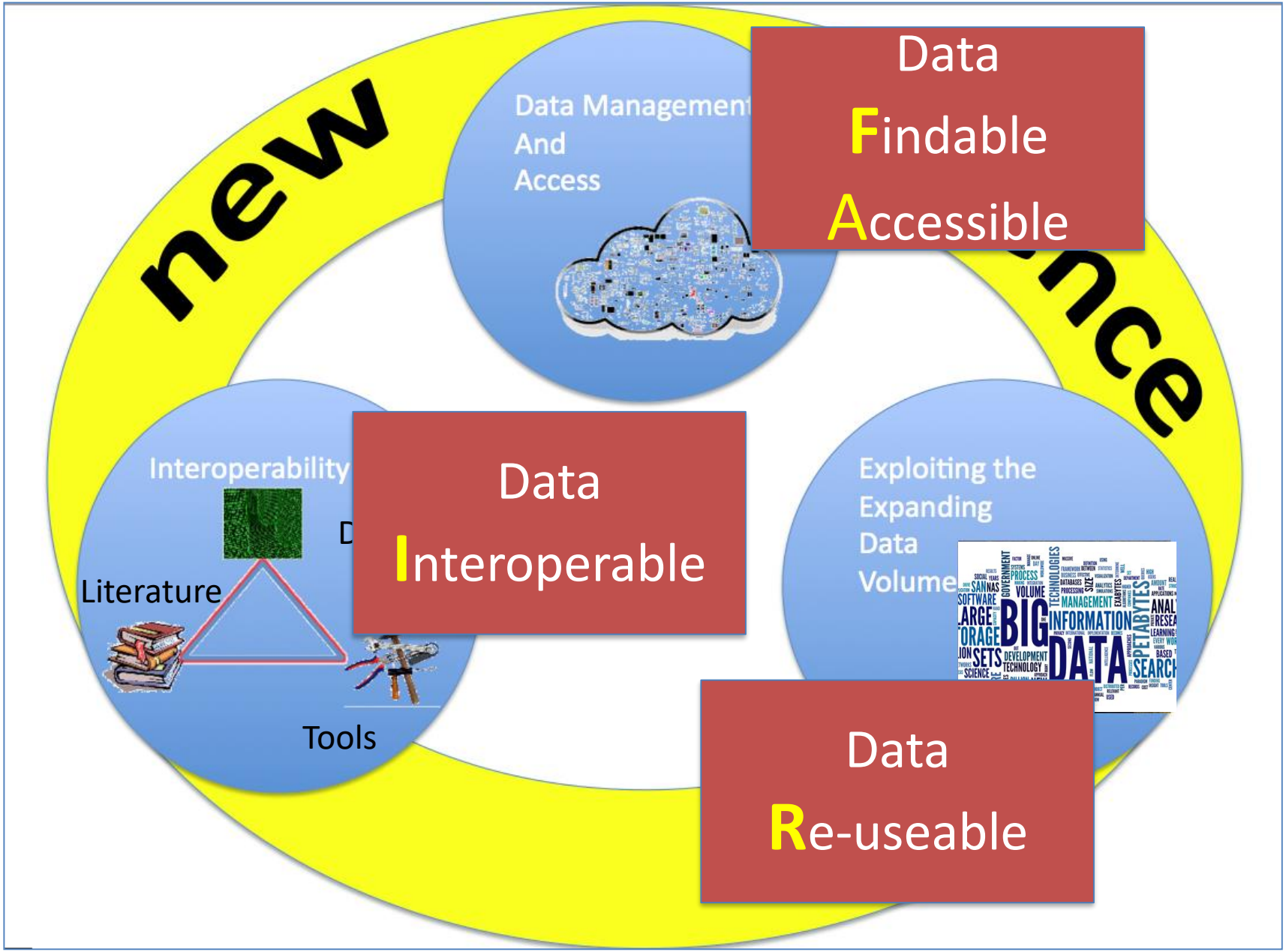
Data Interoperable
Exploiting the Expanding Data Volume


new
Data Management And Access
Data Findable Accessible
Interoperability
Literature
Tools
Data Interoperable
Exploiting the Expanding Data Volume
Data Re-useable


FAIR

# 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-operating data services
- For software providers to offer a variety of compatible analysis and interfaces
- Support in
- Exploit the full

**Standards !**

# 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


ARCTIC OCEAN
Greenland
Svalbard (Nor.)
United States of America
Canada
Iceland
Norway
Sweden
Finland
Russia
United Kingdom
Denmark
Neth.
Ireland
Estonia
Latvia
Belarus
Pol.
Ukr.
Kazakhstan
Mongolia
Georgia
Bulgaria
Portugal
Spain
Turkey
Azer.
Uzb.
Turkm.
Kyrgyzstan
Tajikistan
Greece
Tunisia
Lebanon
Syria
Iraq
Iran
Afg.
Pakistan
Nepal
Bhutan
N. Korea
S. Korea
Japan
China
Morocco
Algeria
Libya
Israel
Jordan
Kuwait
Egypt
Saudi Arabia
U.A.E.
Oman
Western Sahara
Mauritania
Mali
Niger
Chad
Eritrea
Yemen
Djibouti
Sudan
Senegal
Guinea-Bissau
Sierra Leone
Liberia
Cote d' Ivoire
Ghana
Togo
Nigeria
Cam.
C.A.R.
Ethiopia
Somalia
Gabon
Dem. Rep. of Congo
Uganda
Kenya
Tanzania
Rep. of the Congo
Angola
Zambia
Malawi
Namibia
Zimbabwe
Mozambique
Madagascar
Botswana
Swaziland
Lesotho
South Africa
Mexico
Guatemala
Honduras
Nicaragua
Costa Rica
Panama
Colombia
Ecuador
Ven.
Guyana
French Guiana
Suriname
Peru
Bolivia
Paraguay
Chile
Argentina
Uruguay
Sri Lanka
Bangl.
Myanmar
Laos
Thailand
Cambodia
Vietnam
Philippines
Taiwan
Malaysia
Indonesia
Papua New Guinea
Solomon Islands
Fiji
New Zealand
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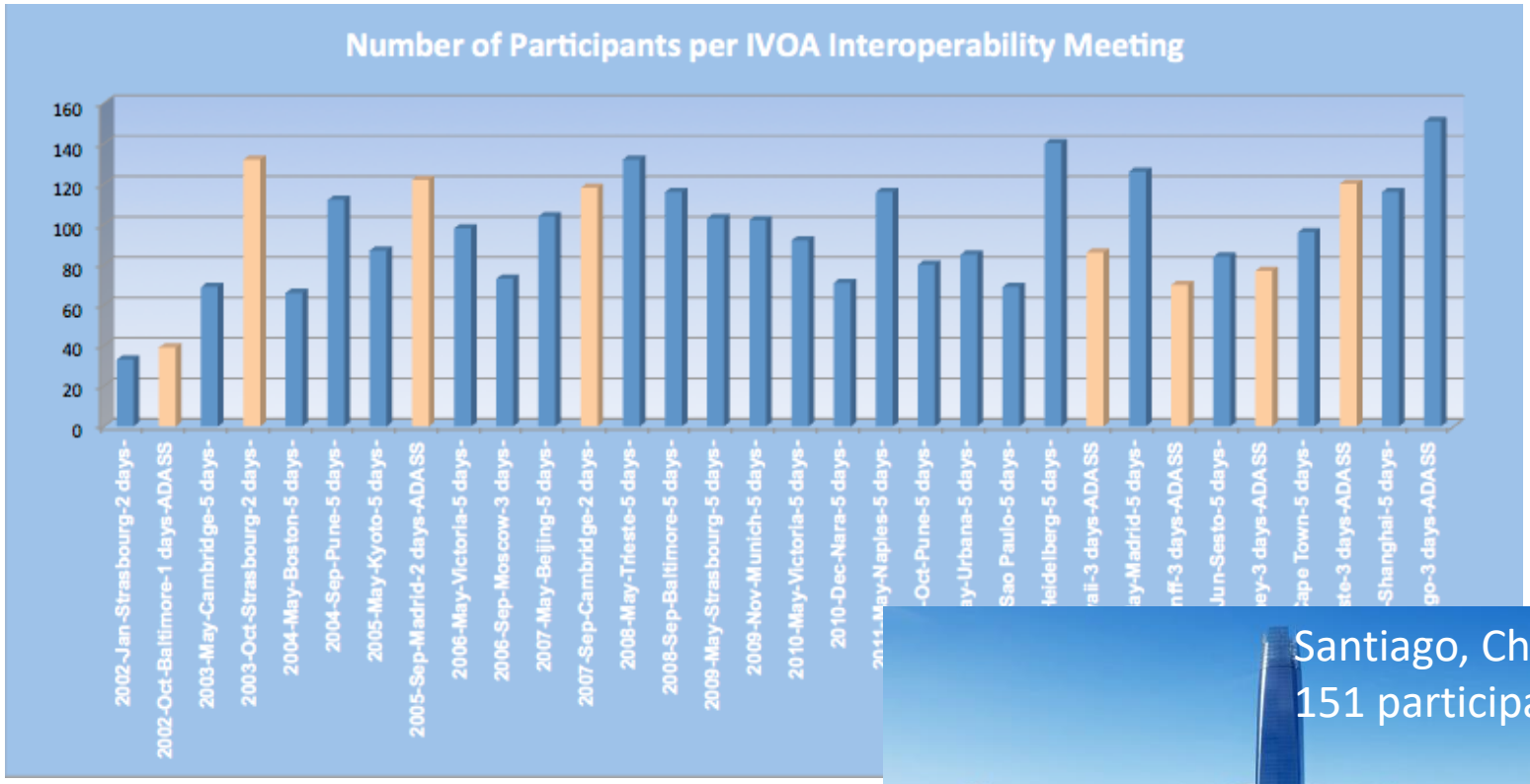
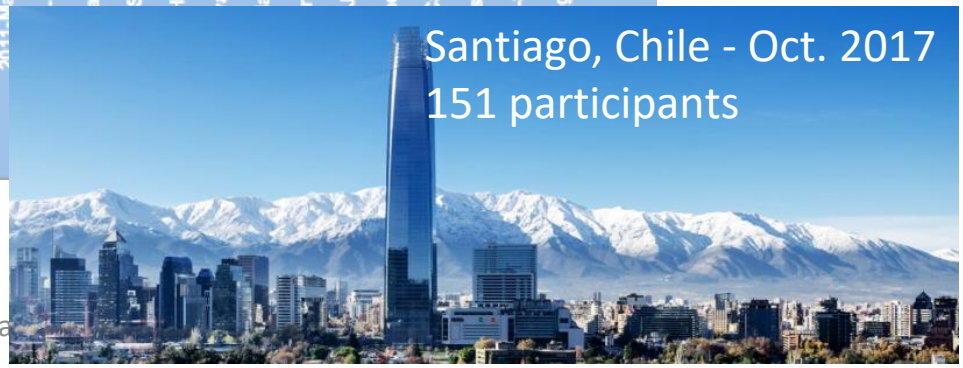
# IVOA Today

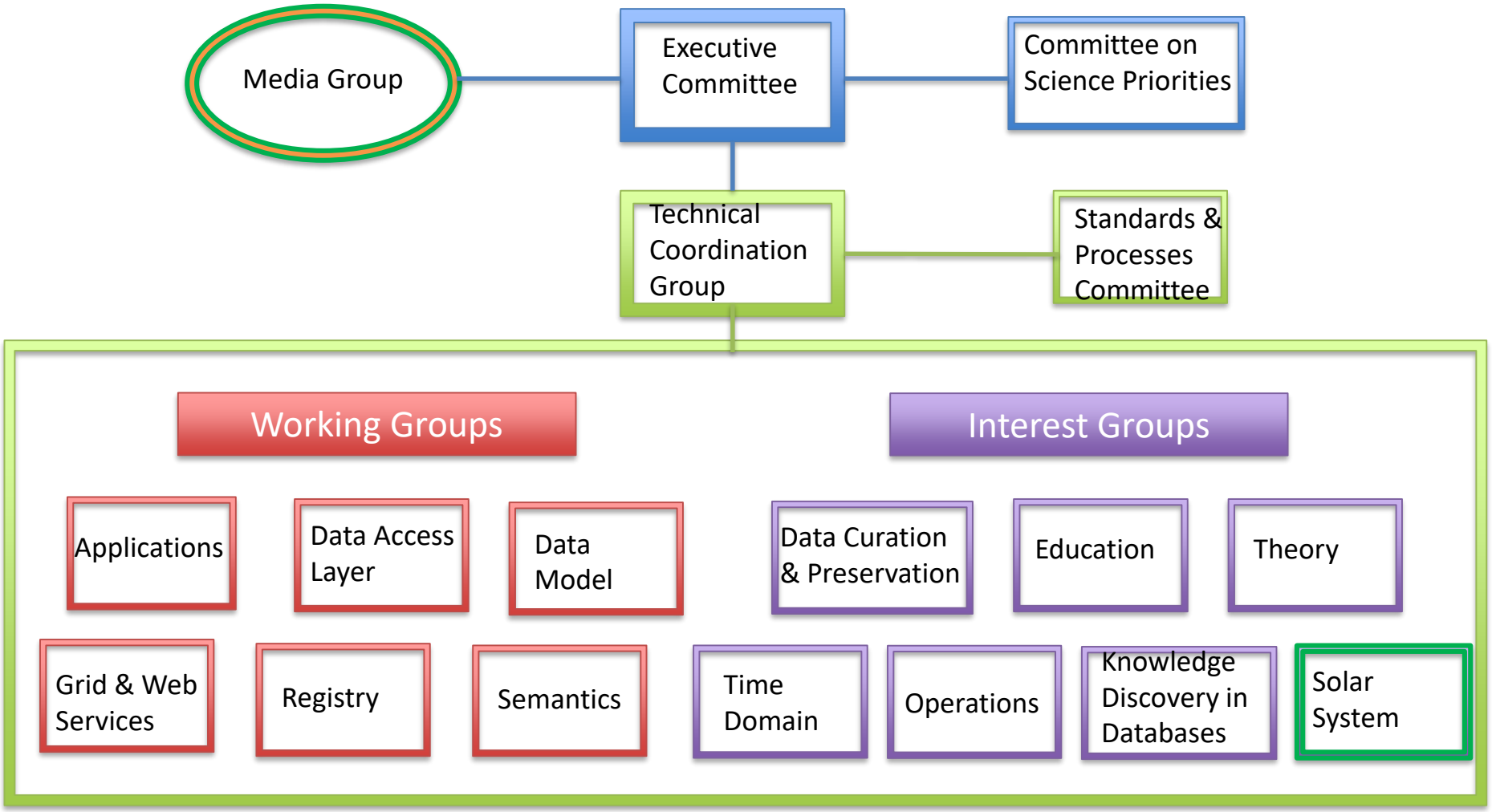
www.ivoa.net

- 2 well attended interoperability working meetings per year



# IVOA Organization Chart



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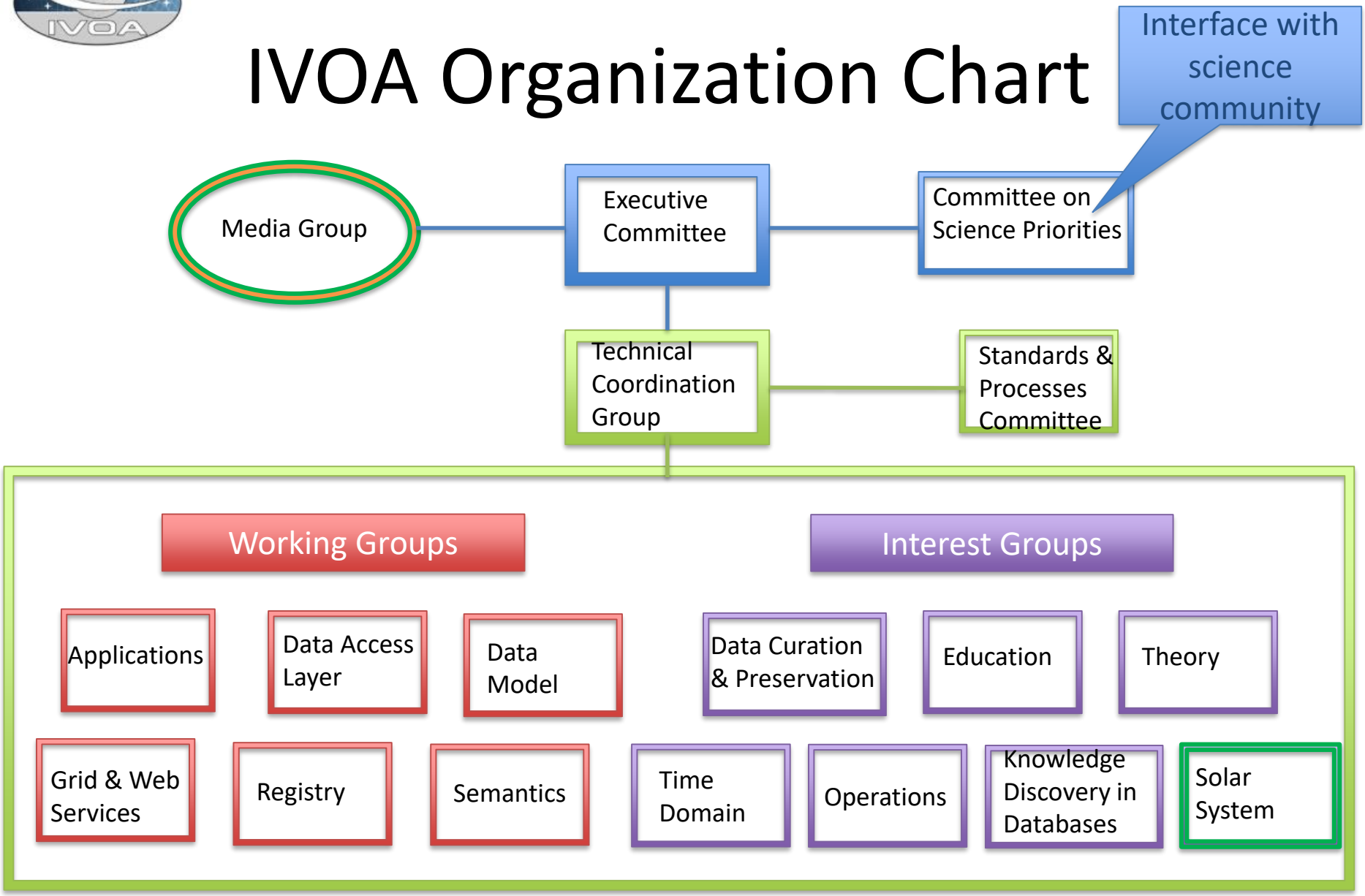

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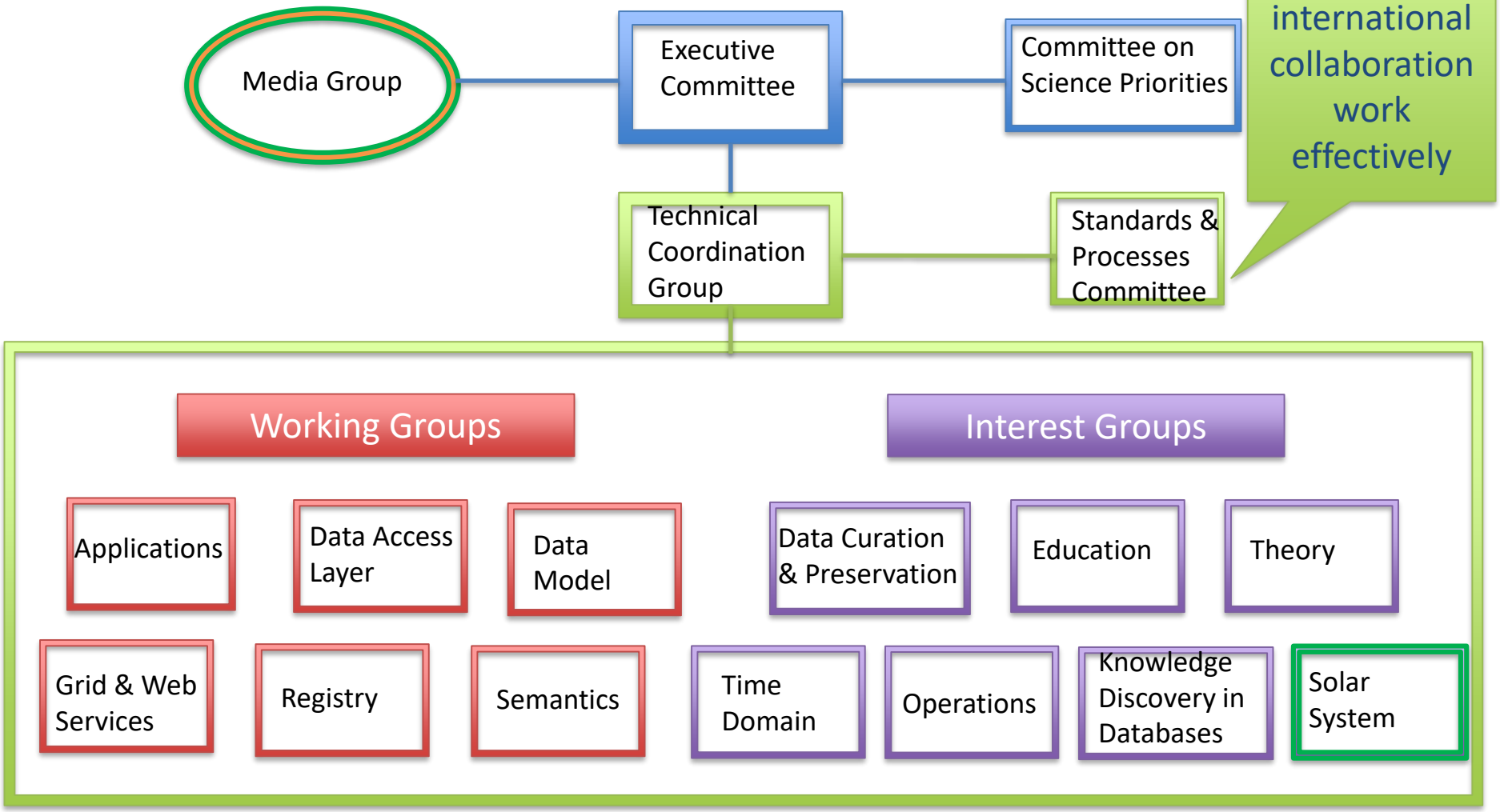

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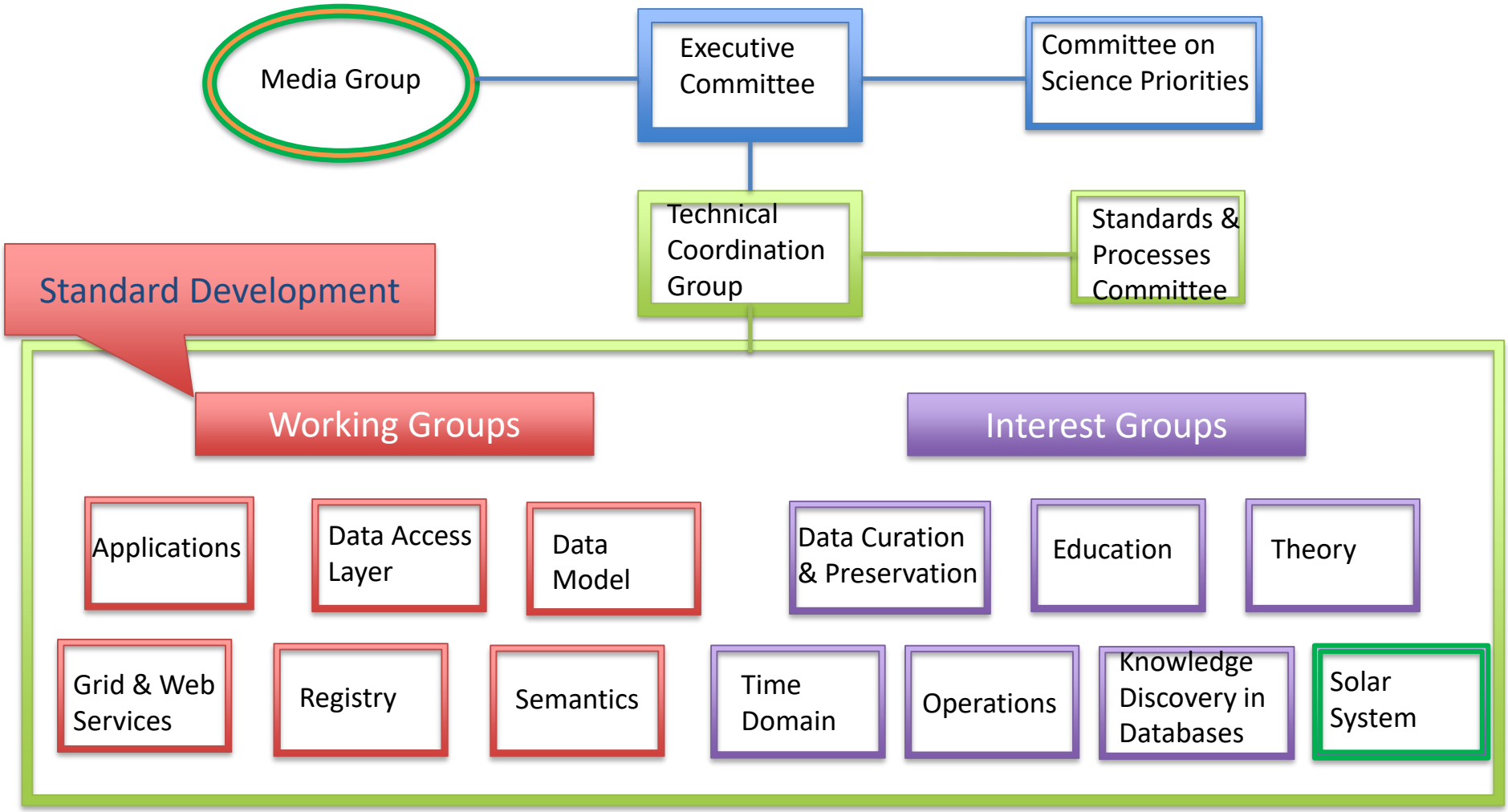

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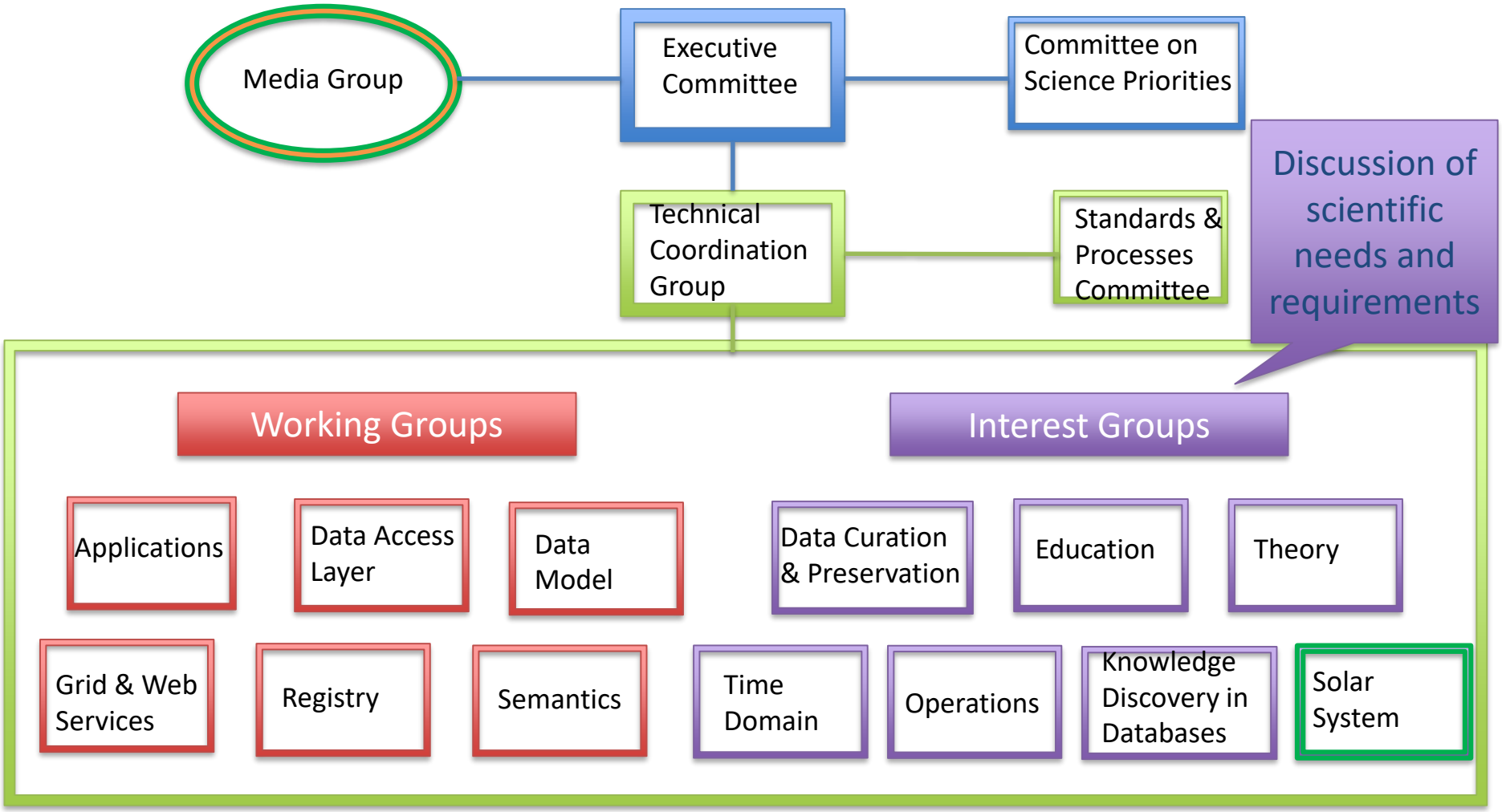
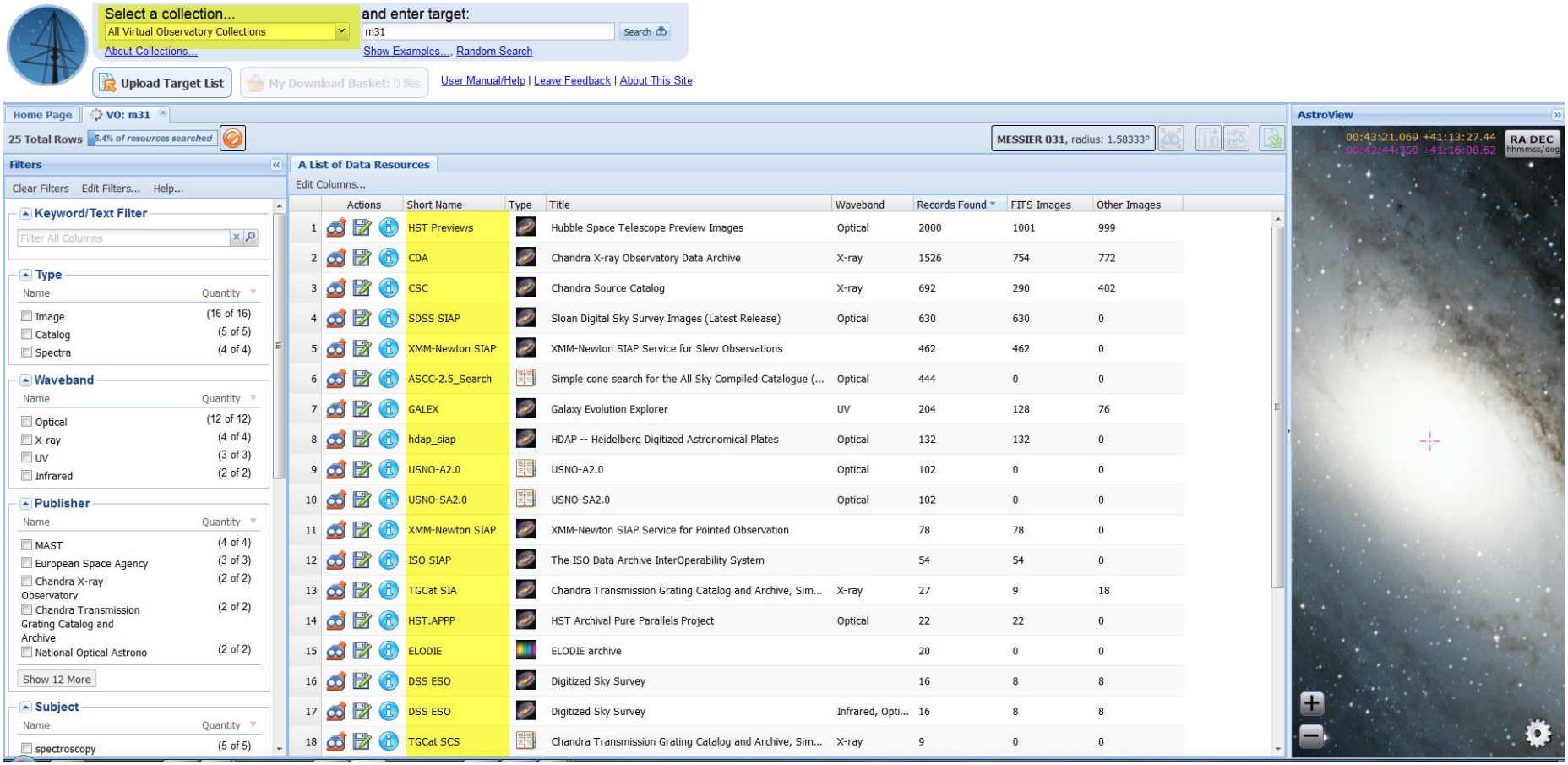


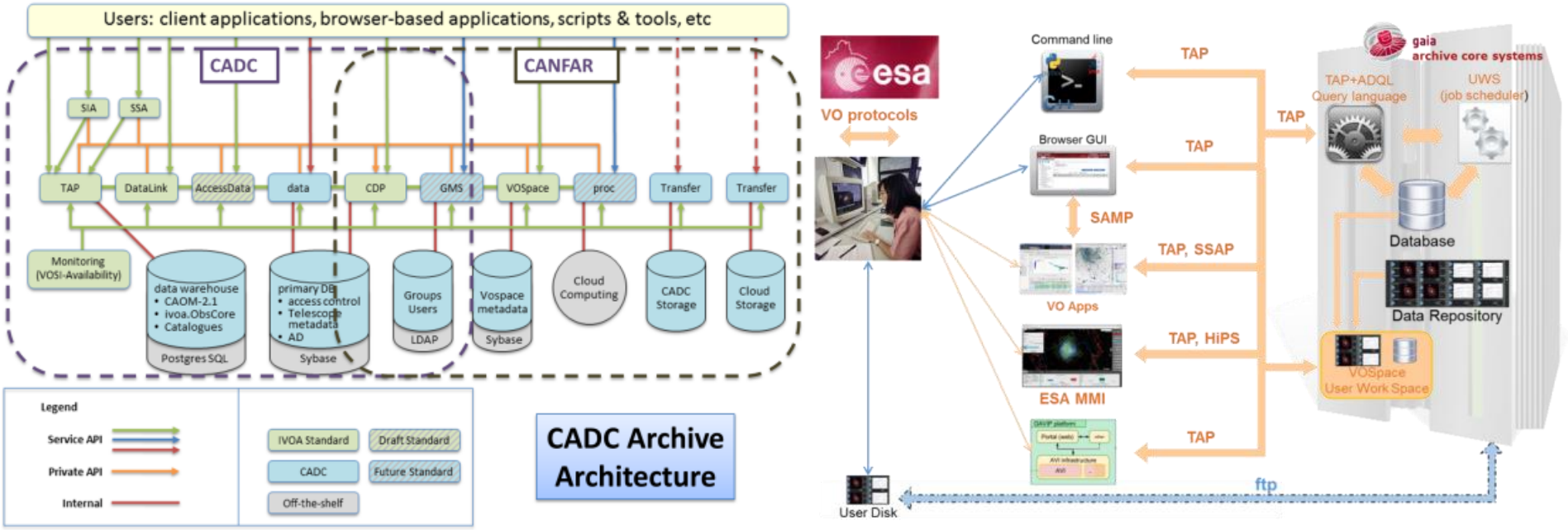
# IVOA Successes –Archives in the VO

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



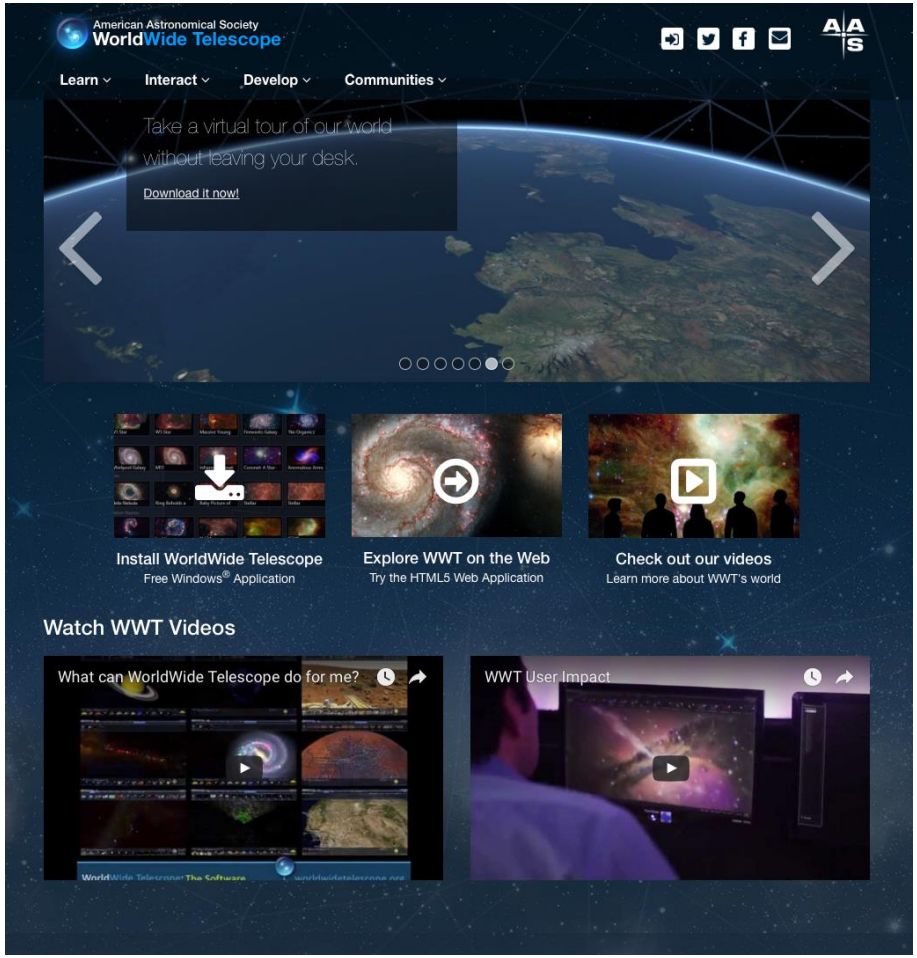
# IVOA Successes – VO in Data Centers

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



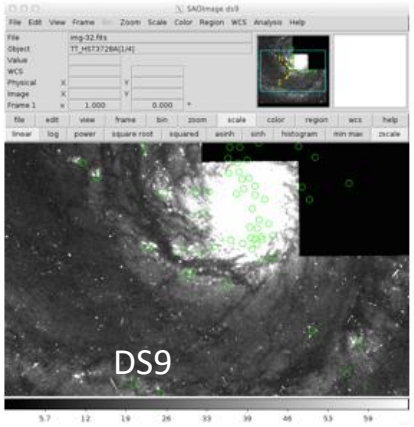
# IVOA compliant 3rd-party applications

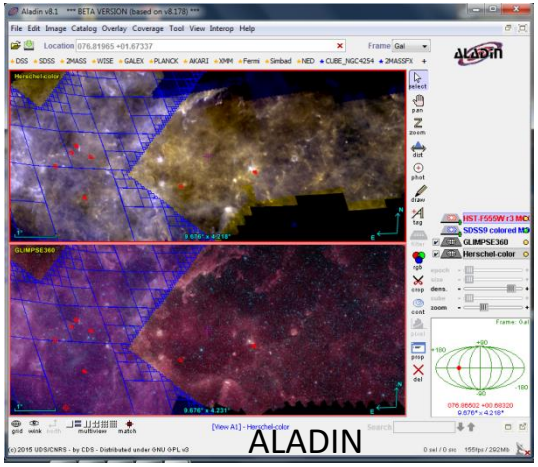
- VO-inspired and VO-compliant
  - WorldWide Telescope (Microsoft)
  - Now under American Astronomical Society management
  - Used for education and outreach in the USA and other countries (e.g., China)

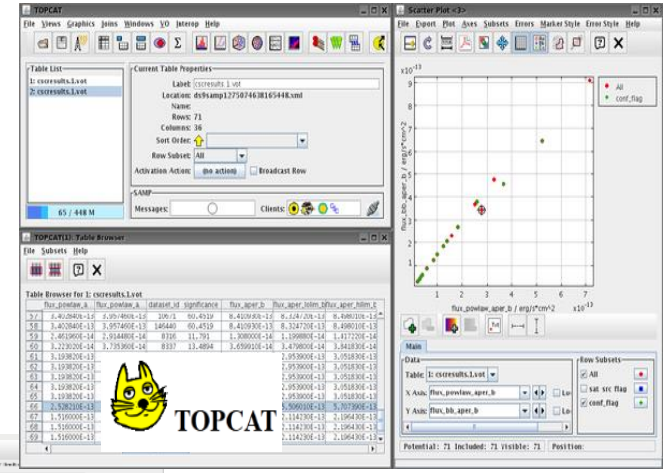


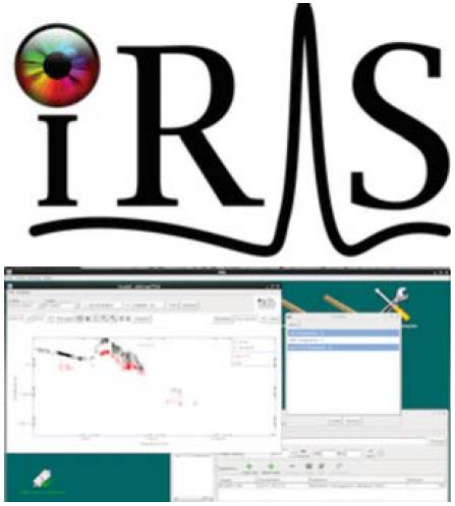
# VO interoperable applications

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

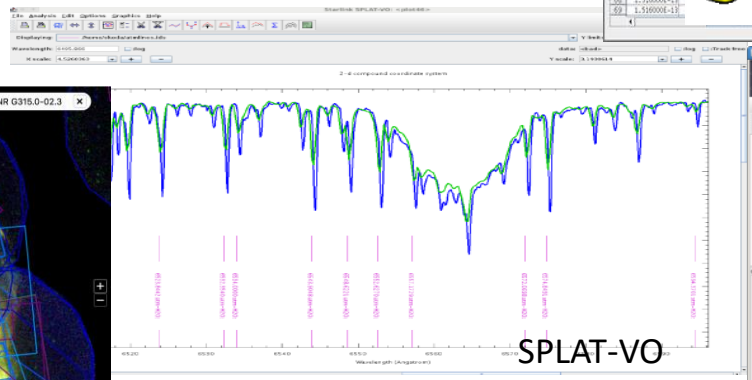


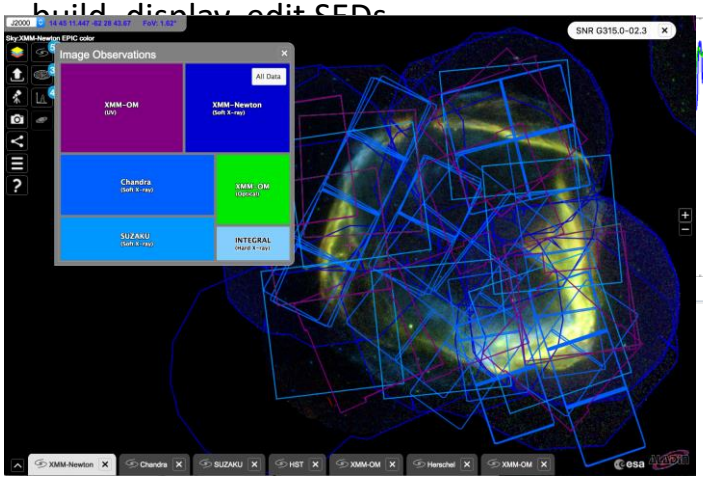



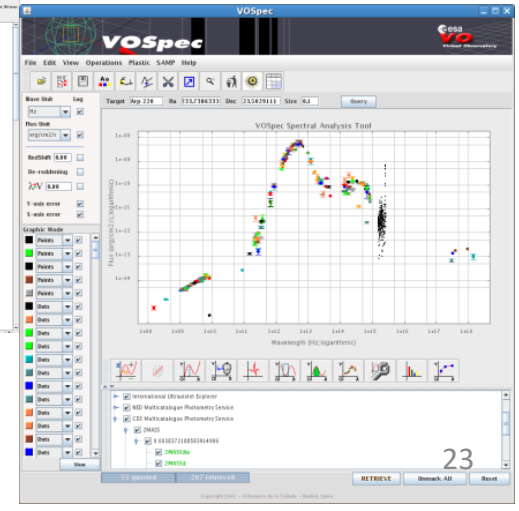



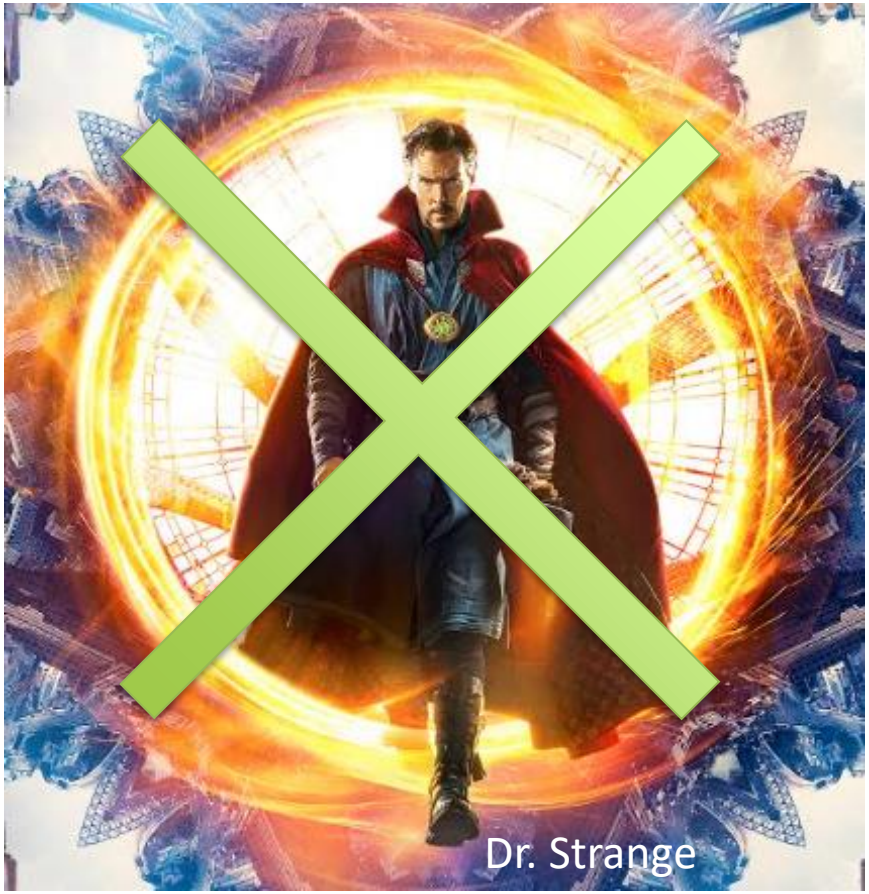
USVOA-IRIS: import, build, display, edit SEDs



# The VO **is not** a Killer Application



# 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