Astrophysical Resource Interoperability

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- ## Astrophysics & Interoperability
  - ### Open & FAIR
- ## Integration in the EOSC scenario
- ## VO take up

What's a "Resource"?

- [...] the term "resource" is used in a general sense for <u>whatever might be identified by a URI</u>. Familiar examples include an electronic document, an image, a source of information with a consistent purpose (e.g., "today's weather report for Los Angeles"), a service (e.g., an HTTP-to-SMS gateway), and a collection of other resources. A resource is not necessarily accessible via the Internet; e.g., human beings, corporations, and bound books in a library can also be resources. Likewise, abstract concepts can be resources [...]

T. Berners-Lee (W3C) "Uniform Resource Identifier (URI): Generic Syntax" - RFC3986 (2005)
[obsoletes, among other, RFC 2396 (URL/RURL)]

- A resource is a general term referring to a VO element that can be described in terms of who curates or maintains it and which can be given a name and a unique identifier. Just about anything can be a resource: it can be an abstract idea, such as sky coverage or an instrumental setup, or it can be fairly concrete, like an organisation or a data collection. This definition is consistent with its use in the general Web community as "anything that has an identity" (Berners-Lee 1998, IETF RFC2396). We expand on this definition by saying that it is also describable.

R. Hanisch & the Registry WG (IVOA) "Resource Metadata for the Virtual Observatory" - 2007

Interoperability

- **Interoperability is a characteristic of a product or system, whose interfaces are completely understood, to work with other products or systems, at present or in the future, in either implementation or access, without any restrictions.**

    - It requires open standards by default

- **Various levels can be defined**

    - Syntactic

        - Common data format, structured content
        - Prerequisite to semantic-level interoperability

    - Semantic

        - Unambiguous shared meaning
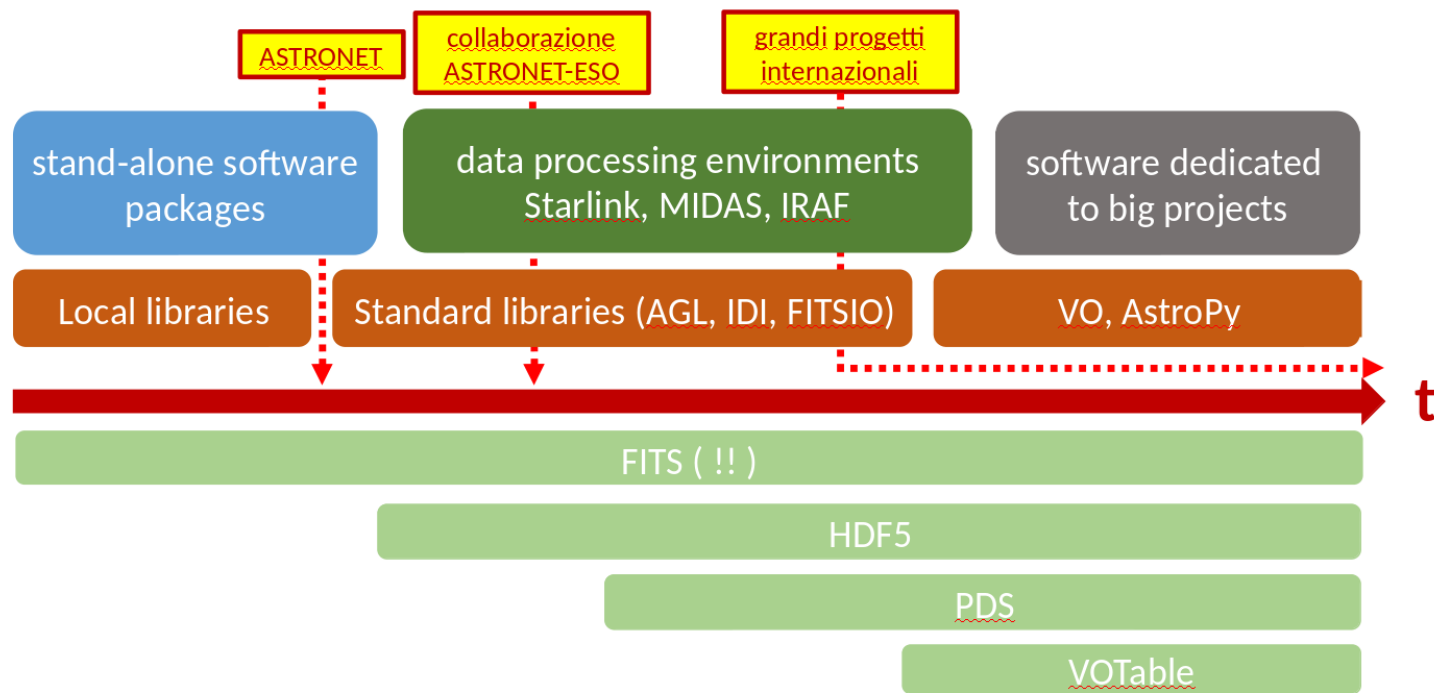   - Needs metadata

Compatibility   De facto standard   Interoperability

Flexible Image Transport System

- An archival format must be utterly portable and selfdescribing, on the assumption that, apart from the transcription device, neither the software nor the hardware that wrote the data will be available when the data are read.

- [...] (FITS), which is the standard archival data format for astronomical data sets.

- Although FITS was originally designed for transporting image data [...] the capabilities of the FITS format have expanded to accommodate more-complex data structures.

(FITS Standard 4.0 / Introduction)

Software e strutture dati

ASTRONET | collaborazione ASTRONET-ESO | grandi progetti internazionali

stand-alone software packages | data processing environments Starlink, MIDAS, IRAF | software dedicated to big projects

Local libraries | Standard libraries (AGL, IDI, FITSIO) | VO, AstroPy

t

FITS (!!)

HDF5

PDS

VOTable

Pasian, INAF ICT 2018

- The Virtual Observatory (VO) is the vision that astronomical datasets and other resources should work as a seamless whole. Many projects and data centres worldwide are working towards this goal. The International Virtual Observatory Alliance (IVOA) is an organisation that debates and agrees the technical standards that are needed to make the VO possible. It also acts as a focus for VO aspirations, a framework for discussing and sharing VO ideas and technology, and body for promoting and publicising the VO.

- **Open standards**

  - Open governance
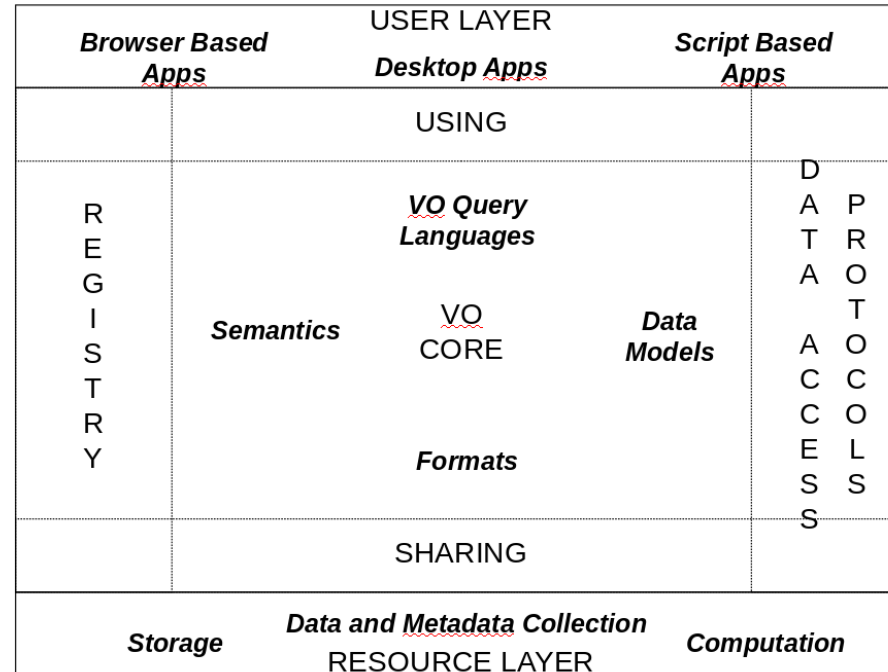
IVOA Architecture
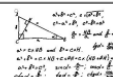
Open Science involves transitioning from a system in which it is difficult to access and locate the results of scientific research to one that openly distributes results to all kinds of end users […]

(Open Science Conference, EU 2016)

Open Science

RESOURCES

SERVICES

Metadata

Persistent ID

Data

Interfaces

Open Data

Semantics

Open Access

Models

Storage   Preservation

Catalogues

Tools

Computing
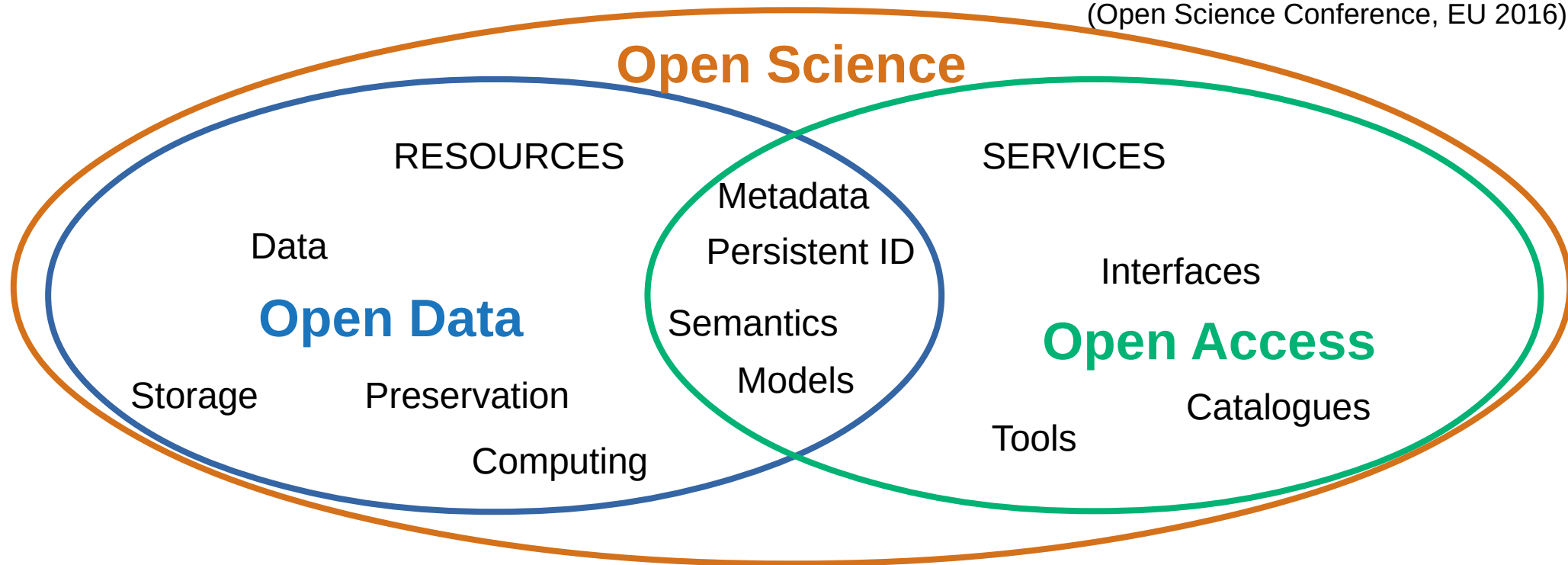
Box 2 | The FAIR Guiding Principles

To be Findable:
F1. (meta)data are assigned a globally unique and persistent identifier
F2. data are described with rich metadata (defined by R1 below)
F3. metadata clearly and explicitly include the identifier of the data it describes
F4. (meta)data are registered or indexed in a searchable resource

To be Accessible:
A1. (meta)data are retrievable by their identifier using a standardized communications protocol
A1.1 the protocol is open, free, and universally implementable
A1.2 the protocol allows for an authentication and authorization procedure, where necessary
A2. metadata are accessible, even when the data are no longer available

To be Interoperable:
I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2. (meta)data use vocabularies that follow FAIR principles
I3. (meta)data include qualified references to other (meta)data

To be Reusable:
R1. meta(data) are richly described with a plurality of accurate and relevant attributes
R1.1. (meta)data are released with a clear and accessible data usage license
R1.2. (meta)data are associated with detailed provenance
R1.3. (meta)data meet domain-relevant community standards
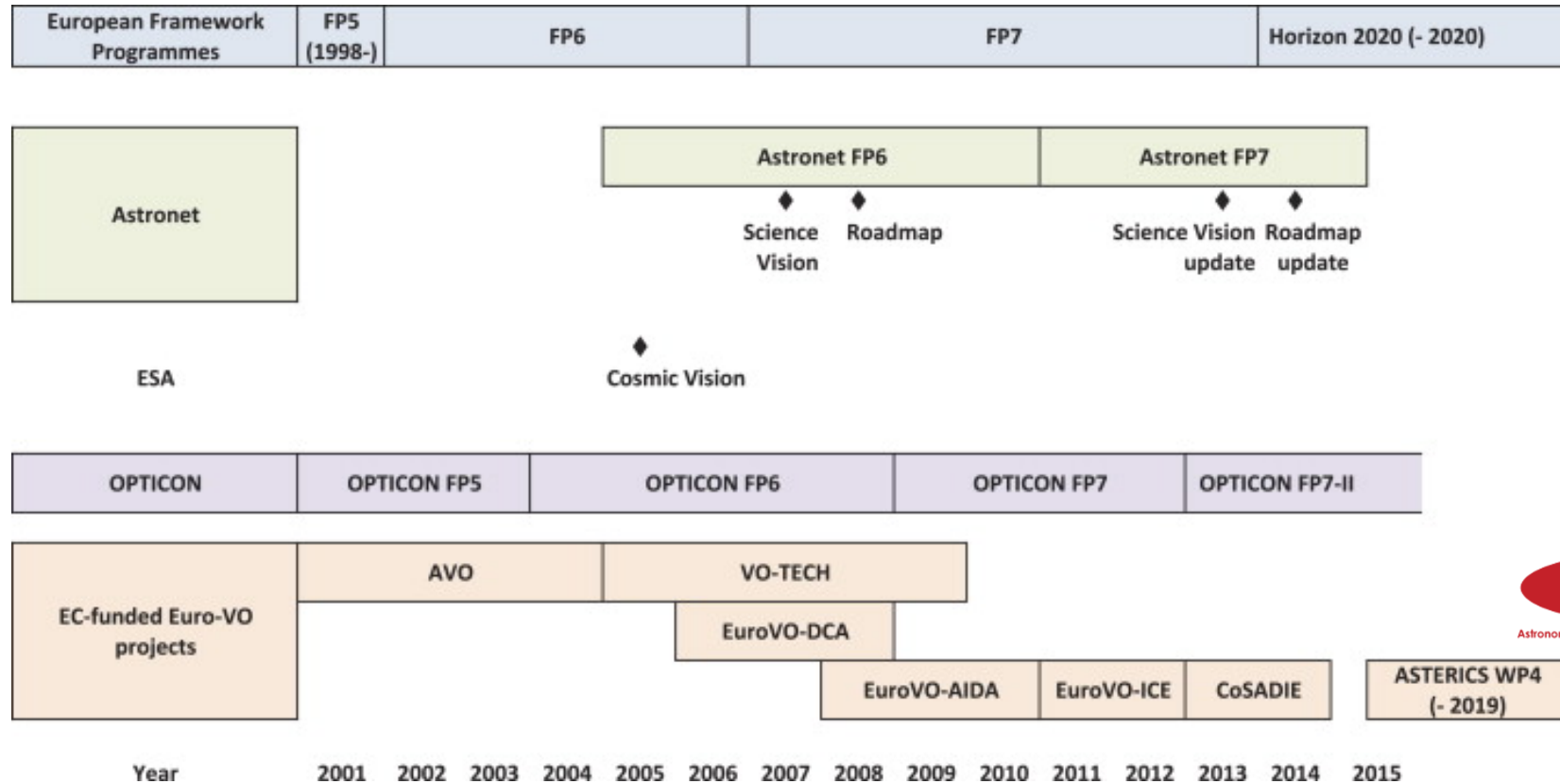
Wilkinson & al. 2016 (Nature)

IVOA FAIR mapping

Genova & al. 2015)

European Framework Programmes	FP5 (1998-)	FP6	FP7	Horizon 2020 (- 2020)

Astronet		Astronet FP6	Astronet FP7

Science Vision — Roadmap

Science Vision update — Roadmap update

ESA — Cosmic Vision

OPTICON	OPTICON FP5	OPTICON FP6	OPTICON FP7	OPTICON FP7-II

EC-funded Euro-VO projects	AVO	VO-TECH		
		EuroVO-DCA		
			EuroVO-AIDA	EuroVO-ICE	CoSADIE	ASTERICS WP4 (- 2019)
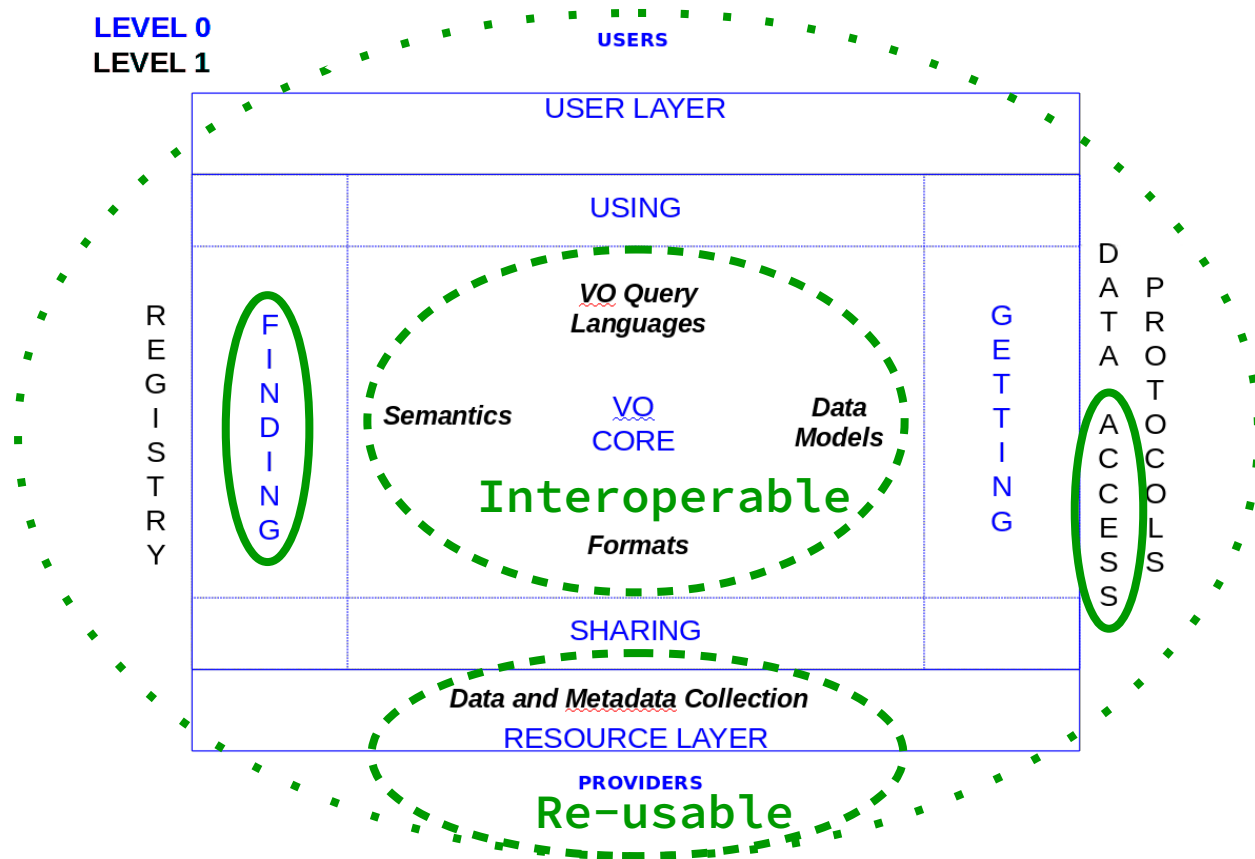
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

- **At EU level, a solution for open science is being promoted**
  - cross-domain

- **In the H2020 context "cluster" projects are starting to cope with it**

- **ESCAPE**
  - "European Science Cluster of Astronomy & Particle physics ESFRI"
  - ~ First step in cross-domain interoperations in physics domain

- **VO integration in EOSC embedded**
  - CEVO (Connecting ESFRI projects to EOSC through VO framework) WP4
    - Integrate VO architecture in the (forming) EOSC one
    - Continuing update/upgrade/develop the VO framework
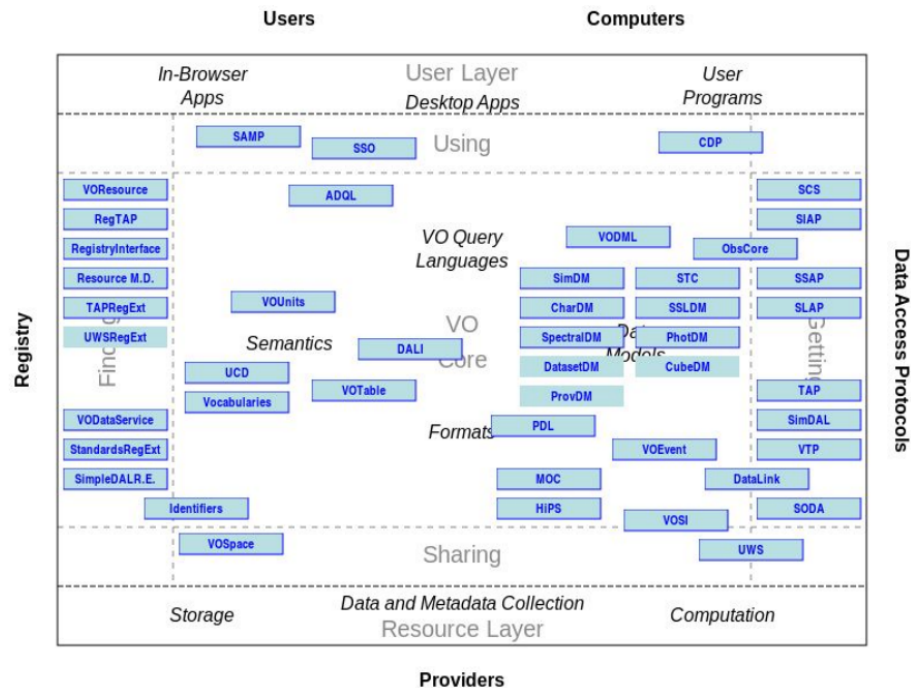
IVOA outcome
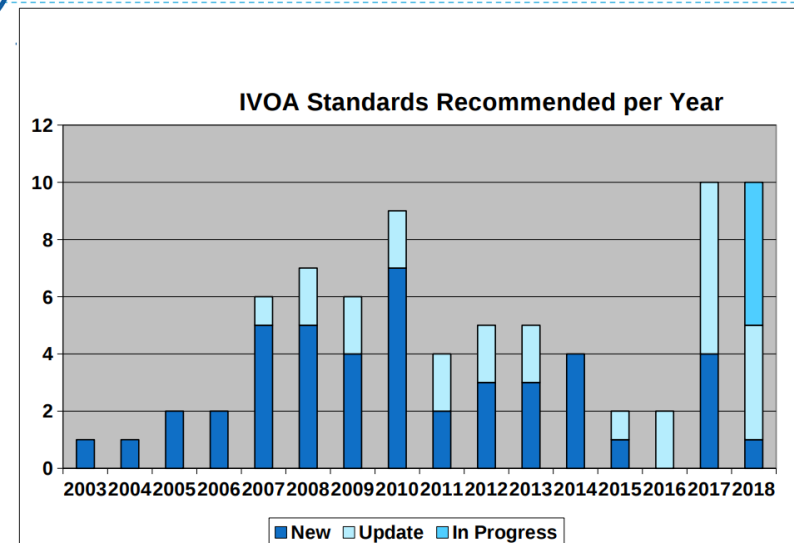
CADC/CANFAR and IVOA

- CADC/CANFAR infrastructure built with IVOA standards
  - Interoperability enabled
  - Programmatic access to all services

- Early implementers/adopters to verify standards meet needs
- Advocating support for authorisation in all services

ADQL	SSO
CDP	TAP
DALI	TAPRegExt
DataLink	UWS
ObsCore	VODataService
RegistryInterfaces	VOResource
SIA	VOSI
SimpleDALRegExt	VOSpace
SODA	VOTable

S. Gaudet (yesterday)

VO take up (examples)

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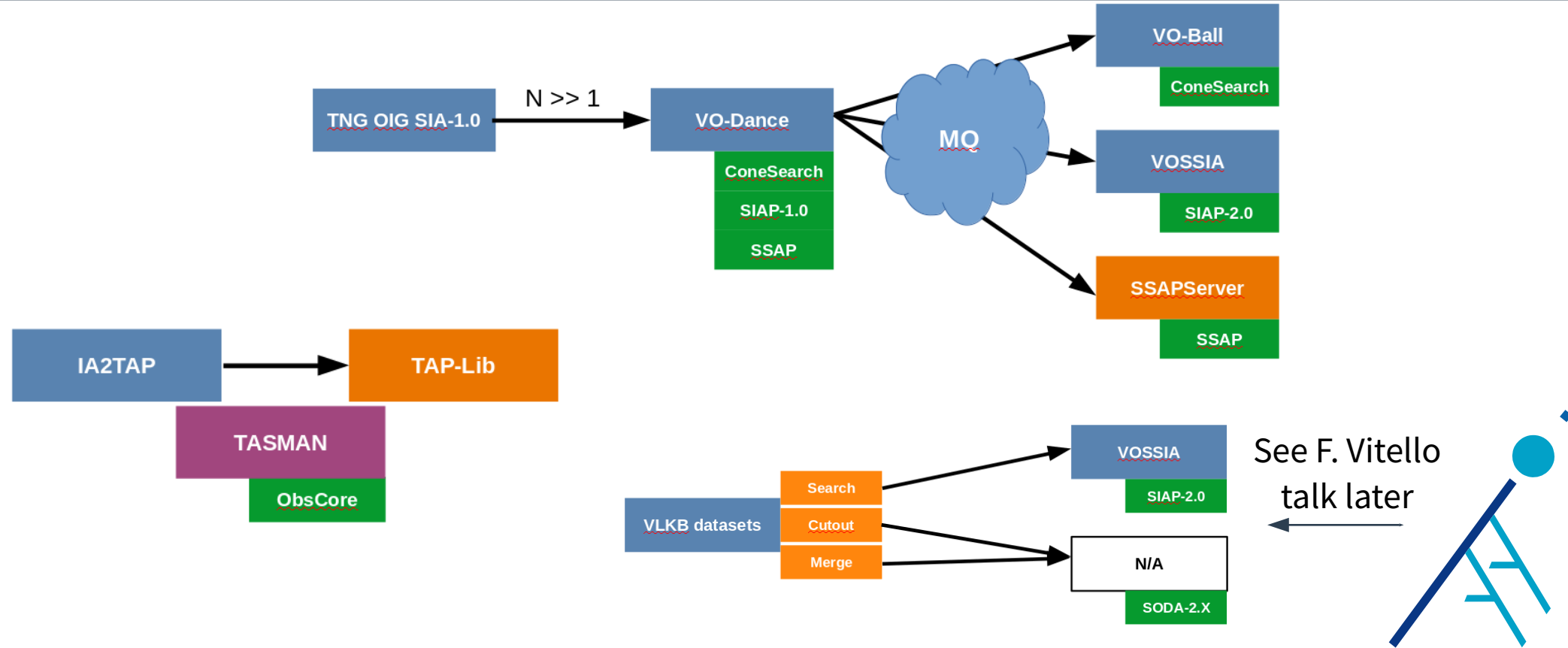

M. Arnaboldi (yesterday)
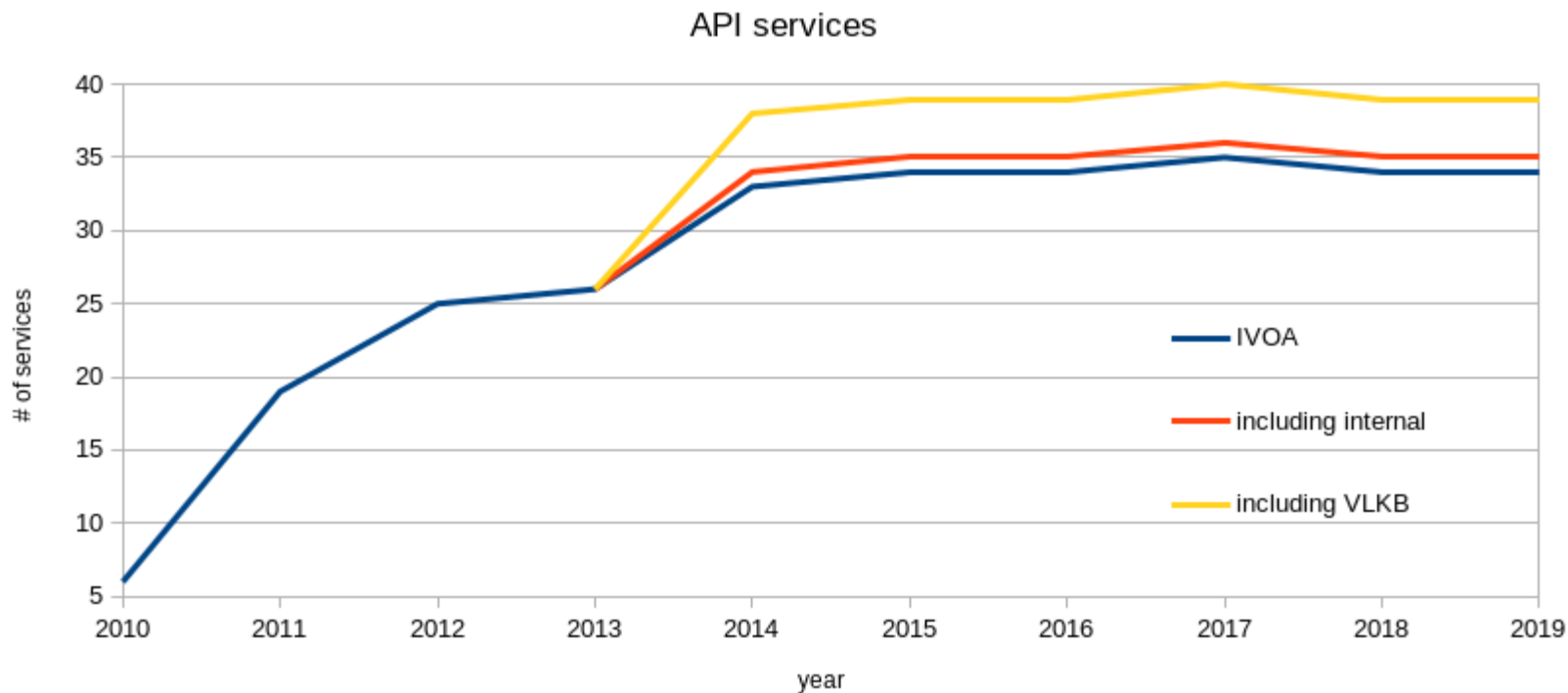
VO take up (examples)

- **Vizier, Simbad, CDS in general**

- **Aladin, TOPCAT, VOSpec, Splat-VO, DS9, …**

- **Astropy, PyVO**

- **…whatever VO aware tool you like**
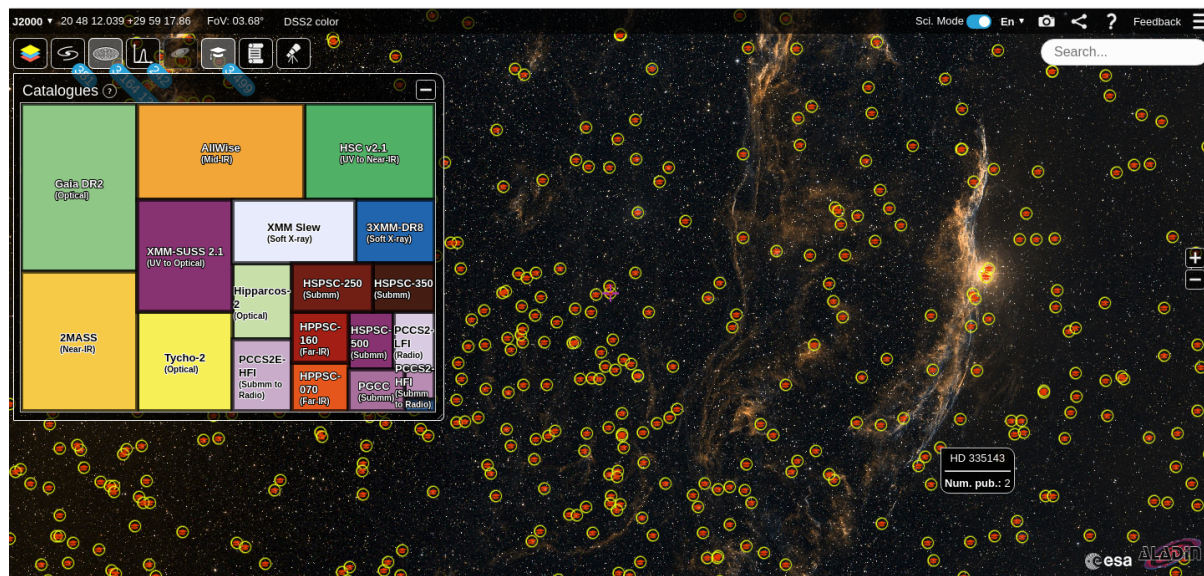
What about us?

What about us?

- **Interoperability has a long history in astrophysics**
  - hidden/invisible... that's fine

- **Interoperability is multi faceted**

  - But it's not simply letting byte-blobs move around the net

- **VO, as the interoperable framework for astrophysics, is NOT a software layer**
  - FAIR principles state it quite clearly

- **VO technologies required a large effort from a lot of stakeholders**

  - don't waste that knowledge

- **VO → an "old" acronym for an evergreen "open" approach**

Summary

- ## New requirements are coming in

  - Computational resources side-by-side with data resources

    - what does it mean interoperability there?

  - User access and grants

    - Don't make the (unauthenticating) many suffer to support the needs of the (authenticating) few

  - Machine learning techniques have different requirements than users at accessing data

Thank you for your attention!

- If you want to go fast go alone, if you want to go far go together
  (old african proverb)

- A better user experience is achieved also building a community