Environmental Research Infrastructures as enablers of open science

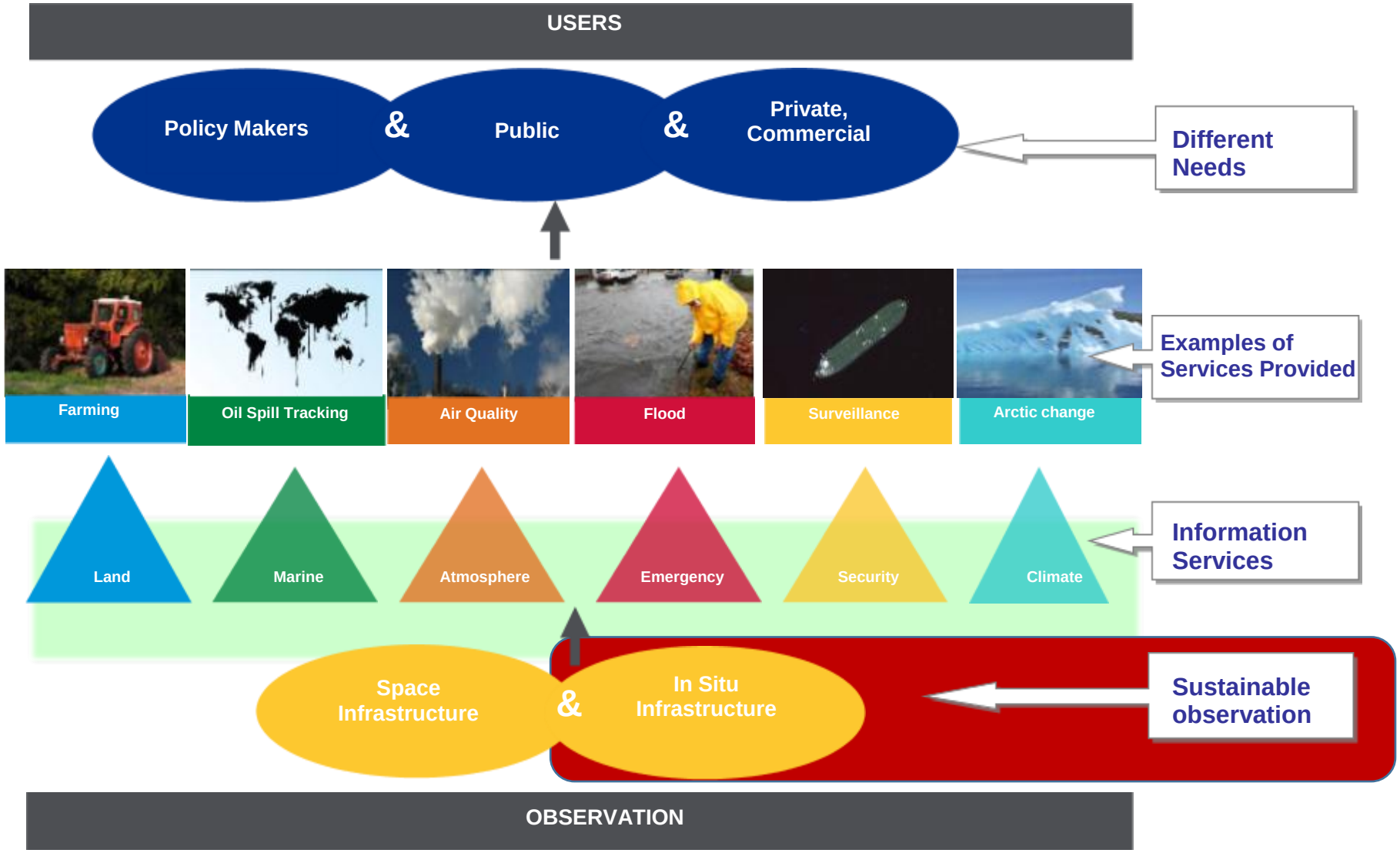
Sanna Sorvari

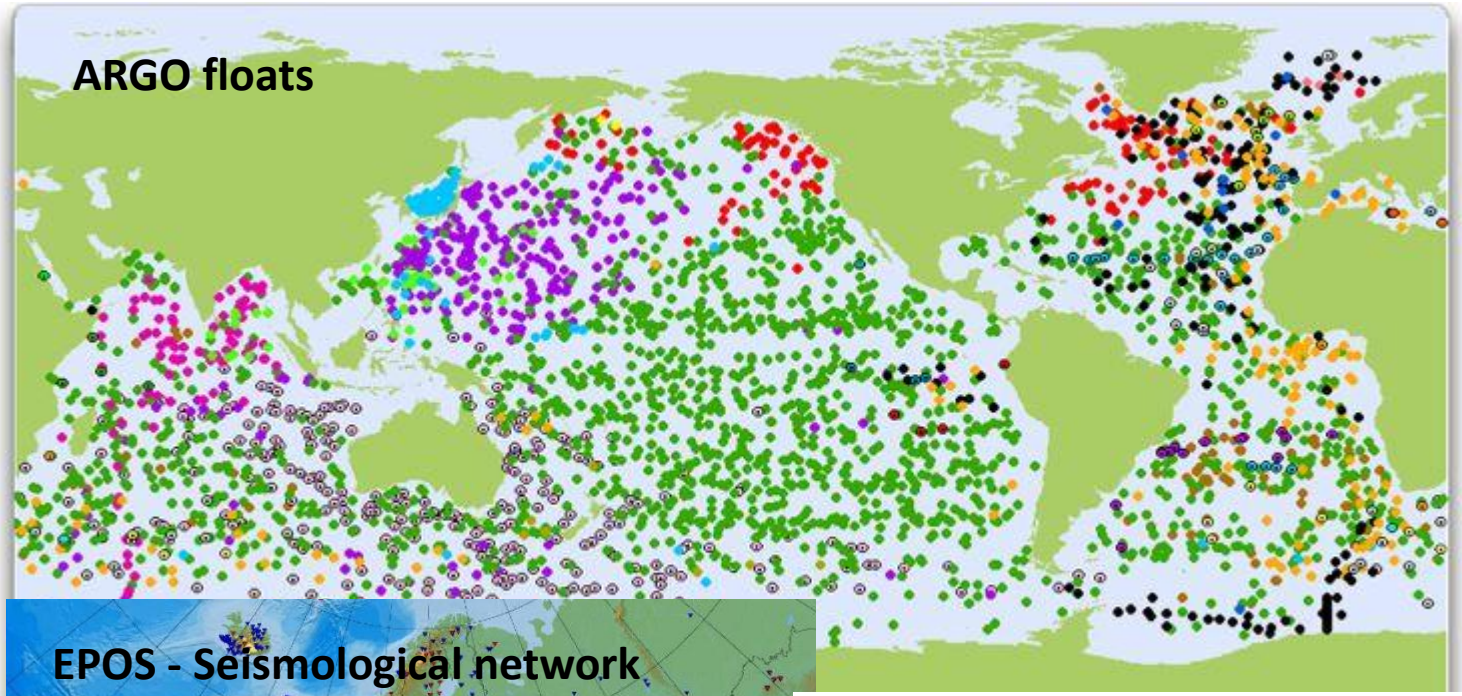
Finnish Meteorological Institute

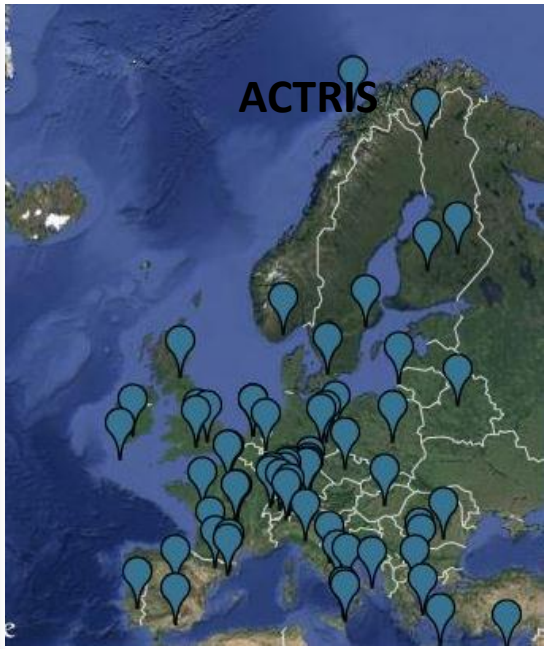
Take home messages

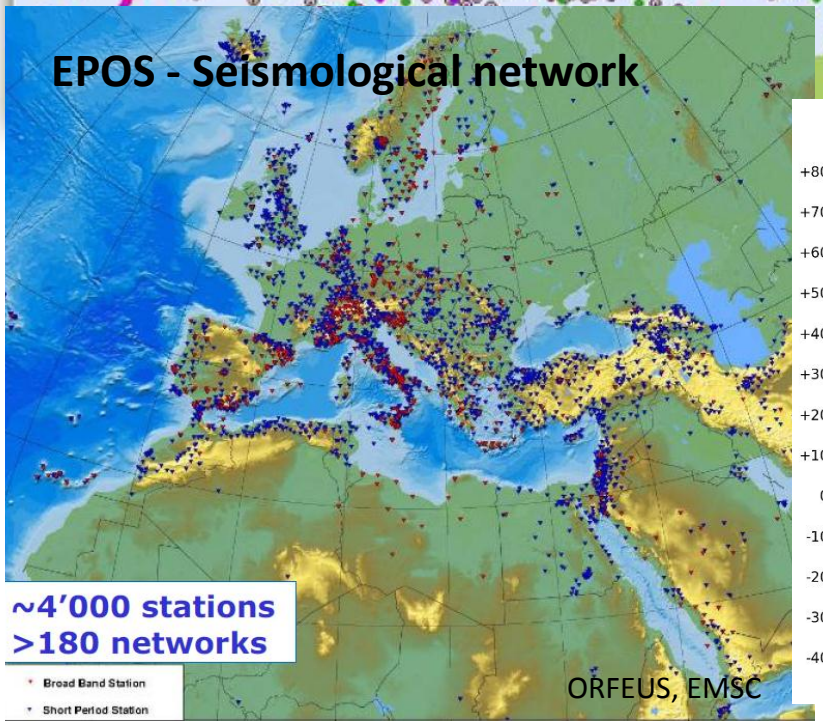
- Ground-based infrastructures are important data providers for Earth observations
- Changing from loose networks to highly managed institutional research infrastructures
- Environmental research infrastructures work together (ENVRI cluster)
- Essential collaboration with remote sensing and modelling communities
- ENV research infrastructures provide sustainable e-infrastructure solutions to support Open Science

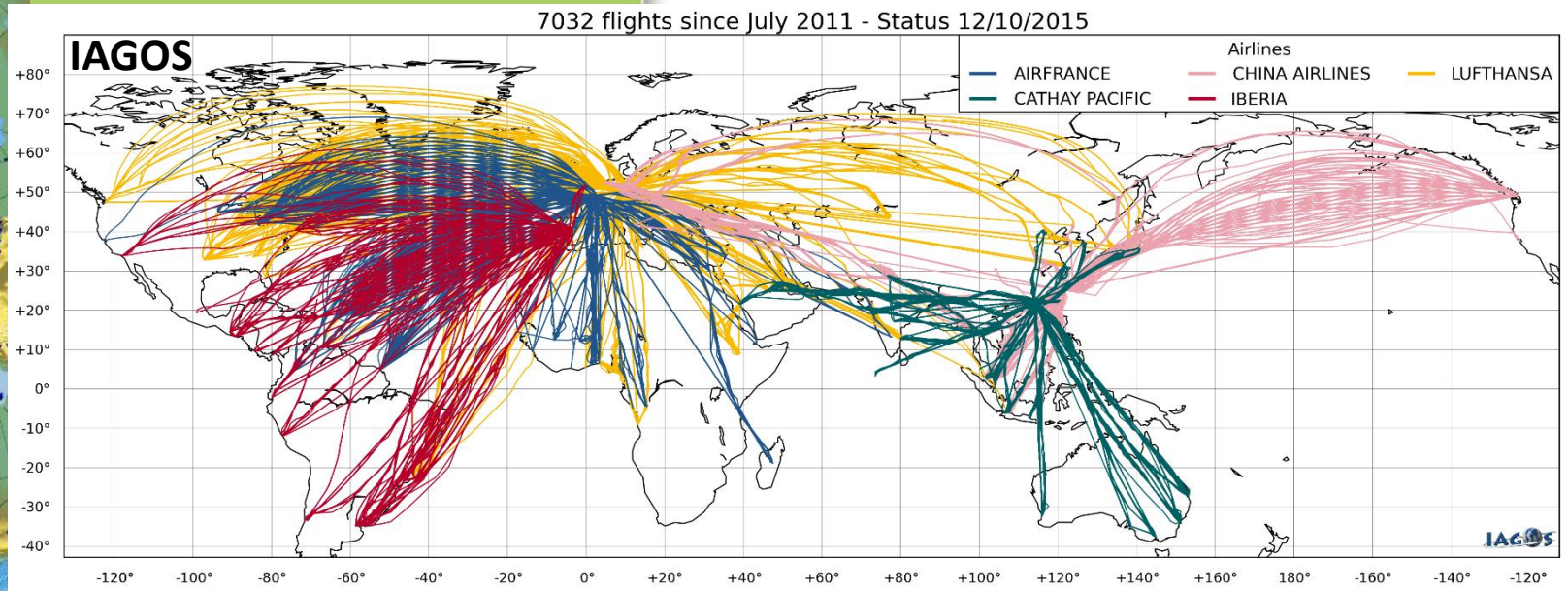
OBSERVATIONS – BACKBONE OF THE SERVICES



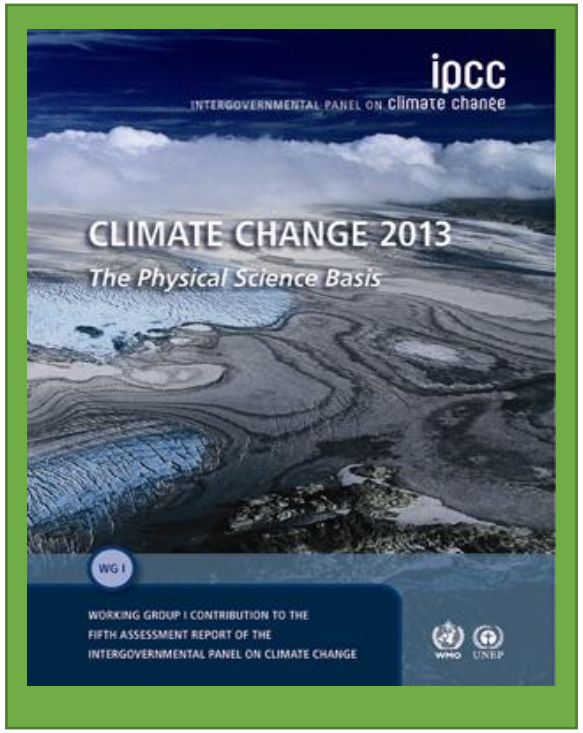

ARGO floats


ACTRIS


EPOS - Seismological network
~4'000 stations
>180 networks
Broad Band Station
Short Period Station
ORFEUS, EMSC


7032 flights since July 2011 - Status 12/10/2015
IAGOS
Airlines
AIRFRANCE
CHINA AIRLINES
LUFTHANSA
CATHAY PACIFIC
IBERIA
+80°
+70°
+60°
+50°
+40°
+30°
+20°
+10°
0°
-10°
-20°
-30°
-40°
-120°
-100°
-80°
-60°
-40°
-20°
0°
+20°
+40°
+60°
+80°
+100°
+120°
+140°
+160°
180°
-160°
-140°
-120°

Towards policy/society-relevant research, and operational products & services



Climate negotiations at Copenhagen (COP 15)

Copernicus
Europe's eyes on Earth

Research Infrastructures

- Facilities, resources and related services provided mainly for the scientific community to conduct top-level research
- Highly coordinated and managed (own legal entities)
- Provide open access (on data and facilities)
- Long-term funding (not projects)
- RIs may be single-sited, distributed and/or virtual

World-class Research Infrastructures

Essential for Europe's researchers to stay at the forefront of research development

Key component of Europe's competitiveness in "frontier" research

Key Challenges:

- to overcome fragmentation in Europe
- to cope with increasing costs / complexity
- to improve the efficiency of (and access to) research services, incl. e-infrastructures

ESFRI - European Strategy Forum on Research Infrastructures

- Launched in 2002
- A forum of Member States, Associated States, and European Commission
- The ESFRI Roadmap 2006, update 2008, 2010 (new roadmap in 2016)
- The ESFRI roadmap contains currently 48 projects

NOTE! ESFRI is not funding RIs

ESFRI gives the European label, Member States funds the construction and operations

The ESFRI roadmap

Social Sc. & Hum. (5)	Life Sciences (13)		Environmental Sciences (8)		Energy (7)	Material and Analytical Facilities (6)	Physics and Astronomy (10)		e-Infra-structures (1)
SHARE	BBMRI	ELIXIR	ICOS	EURO-ARGO	ECCSEL	EUROFEL	ELI	TIARA*	PRACE
European Social Survey	ECRIN	INFRA FRONTIER	LIFEWATCH	IAGOS	Windscanner	EMFL	SPIRAL2	CTA	
CESSDA	INSTRUCT	EATRIS	EMSO	EPOS	EU-SOLARIS	European XFEL	E-ELT	SKA	
CLARIN	EU-OPENSCREEN	EMBRC	SIOS	EISCAT_3D	JHR	ESRF Upgrade	KM3NeT	FAIR	
DARIAH	Euro BioImaging	ERINHA BSL4 Lab			IFMIF	NEUTRON ESS			
	ISBE	MIRRI			HiPER	ILL20/20 Upgrade			
	ANAEE				MYRRHA				

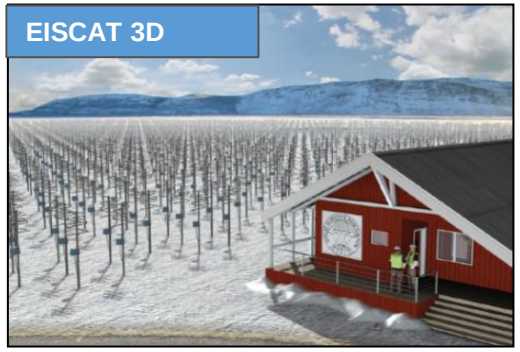
Distributed research infrastructures

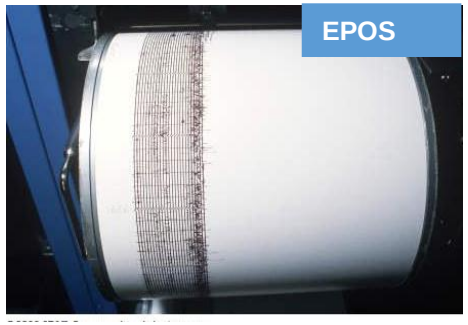
Single sited research infrastructures

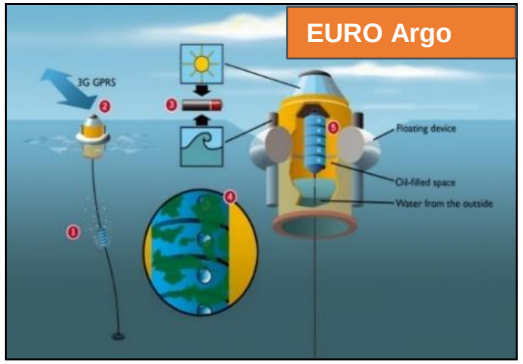
ENV RIs - Construction costs over 1 billion €, annual operational costs around 100 M€

> Member state effort

EC H2020 Research Infrastructure and e-Infrastructure Work Programme support 2.5 billion € in 2014 – 2020

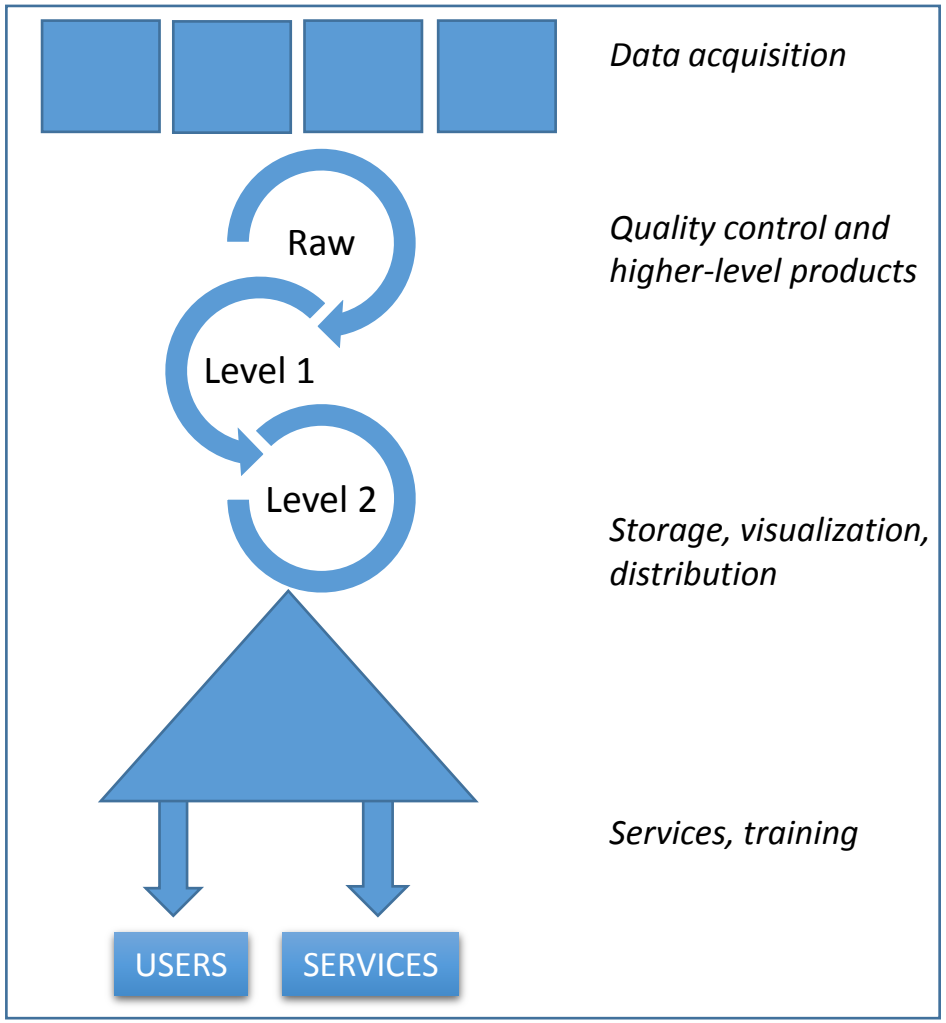






+ many in-situ RI networks funded by EC

EUROPEAN ENVIRONMENTAL RESEARCH INFRASTRUCTURES



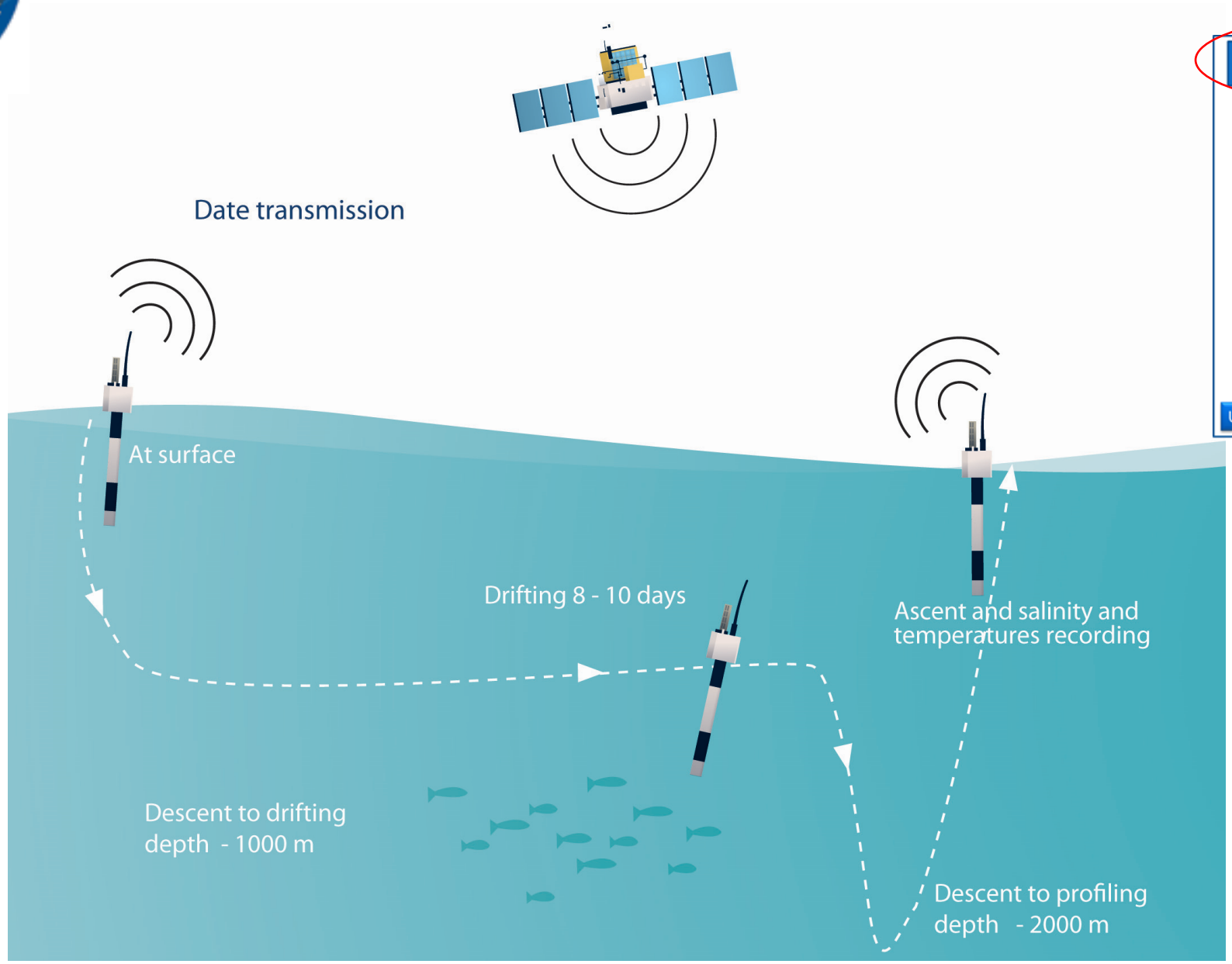
Designed as long-term entities to meet the requirements of continuous environmental observation;

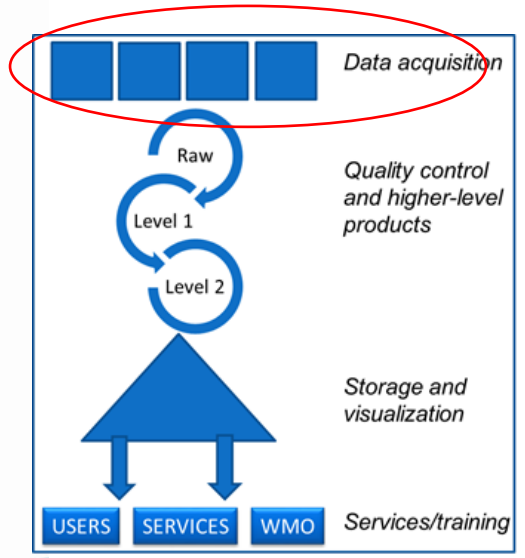
Comprise major scientific equipment as well as knowledge-containing resources such as collections, archives and thematic data

Support access and services within their data and RI facilities.

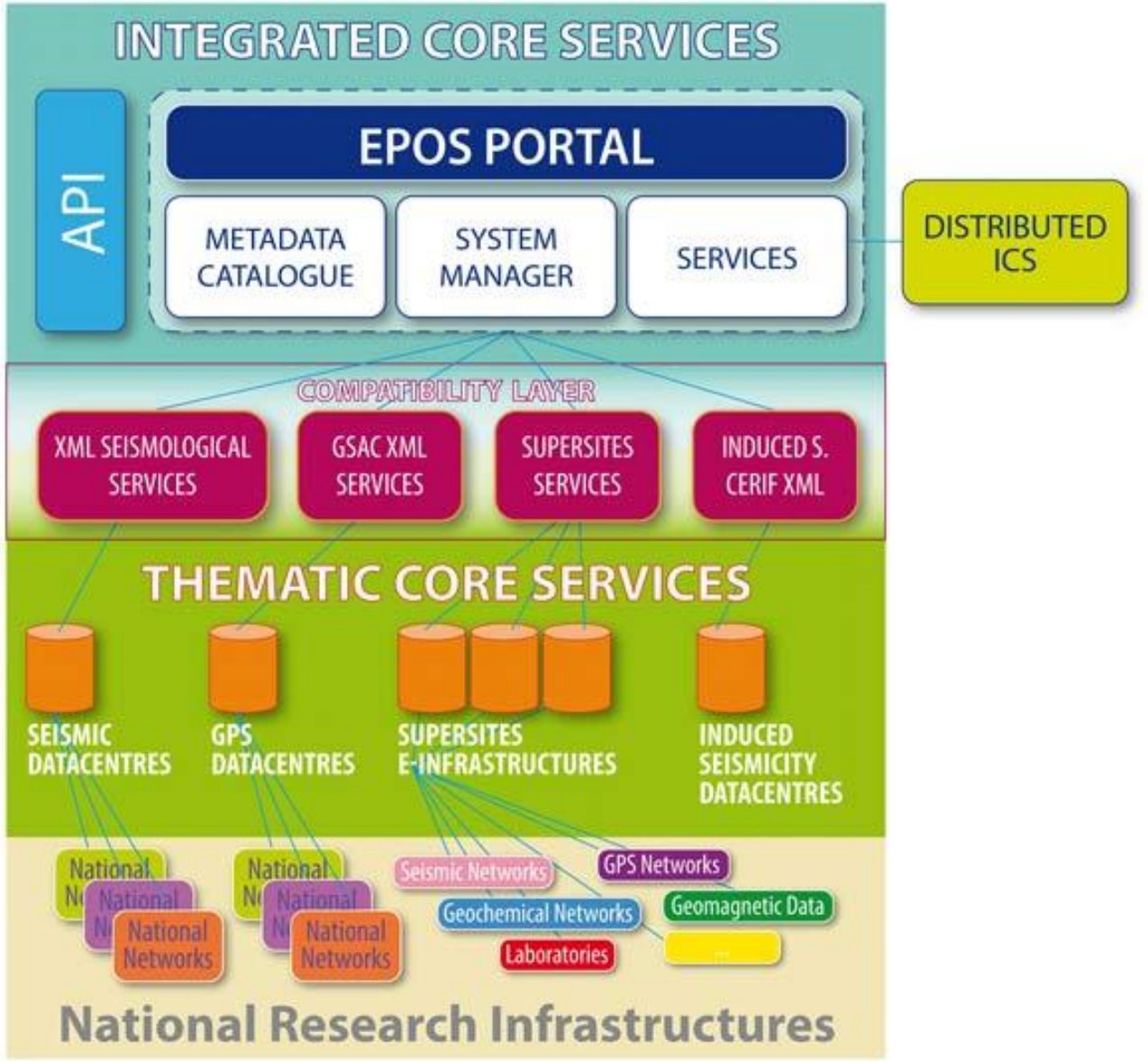
Have well developed e-infrastructure component

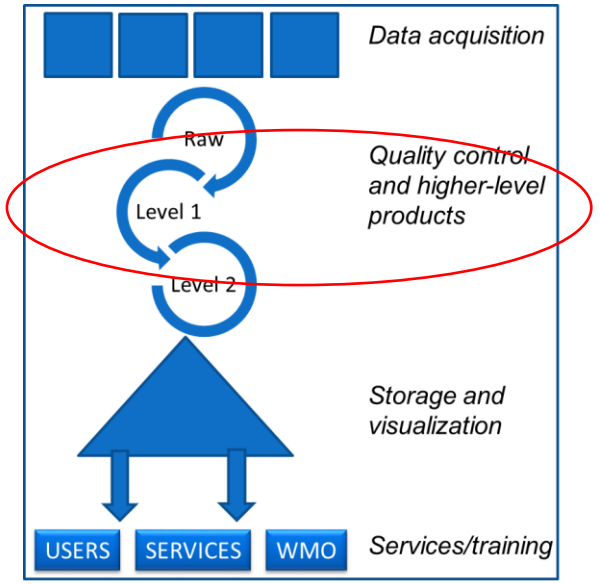
excellence in acquisition/transmission technologies





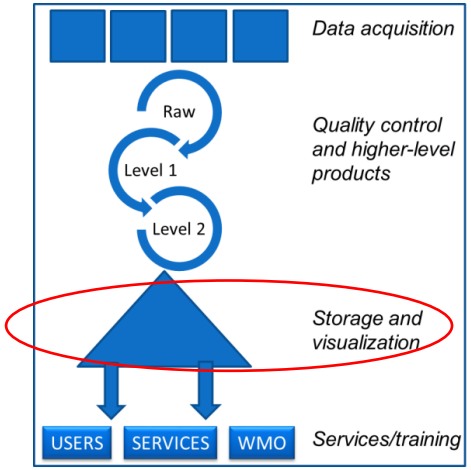
Advanced system for federated data and data mining



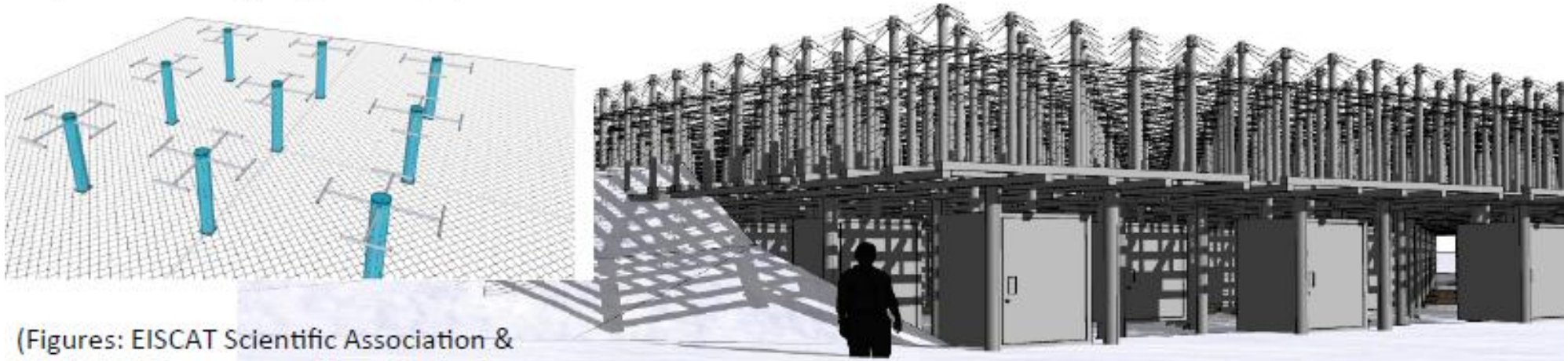


From few dish radars to field of antennas (> 10 000) - volume and storage challenge

- Low-level data challenge: 20Tbs/s/site > 200 PB per day
- Connecting the data and operations of radar sites
- High-level data challenge (diverse science community, request of keeping the data over 11 years solar cycles)
  > huge storage challenge



a possible design of EISCAT_3D to be constructed 2015 ->>



(Figures: EISCAT Scientific Association & EISCAT_3D Preparatory Phase Project)

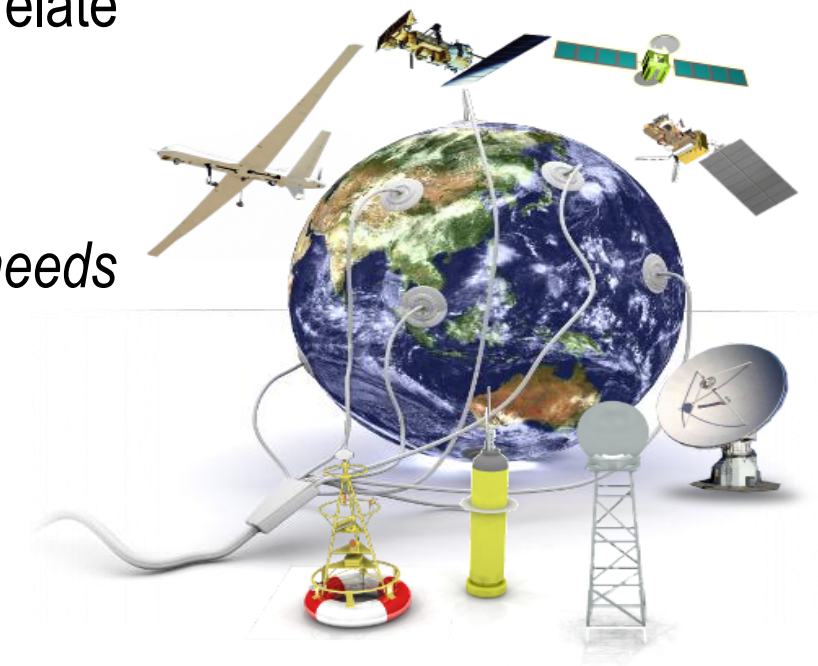
Mann, Häggström & EISCAT_3D project team, NeIC 2015 Conference

http://www.envriplus.eu/

Environmental RI cluster

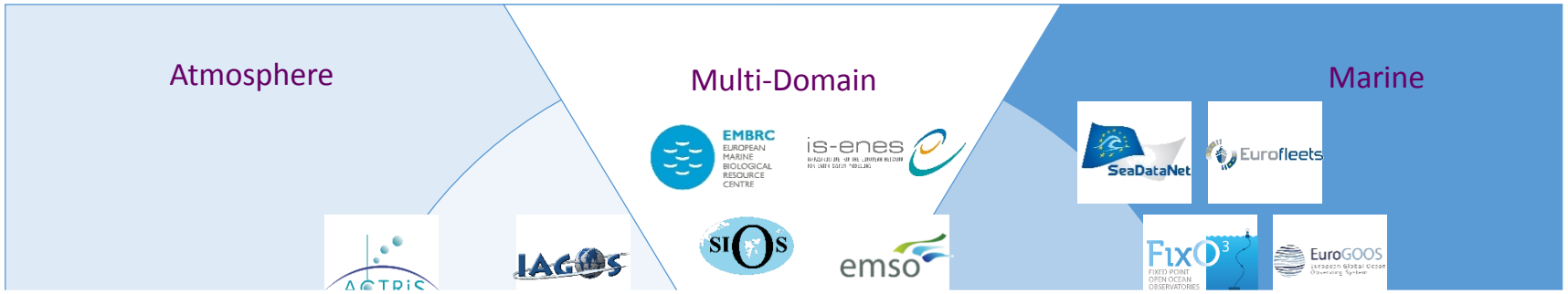
Enable multidisciplinary scientists to access, study and correlate data from multiple domains for system level research

by providing solutions and guidelines for the RIs common needs

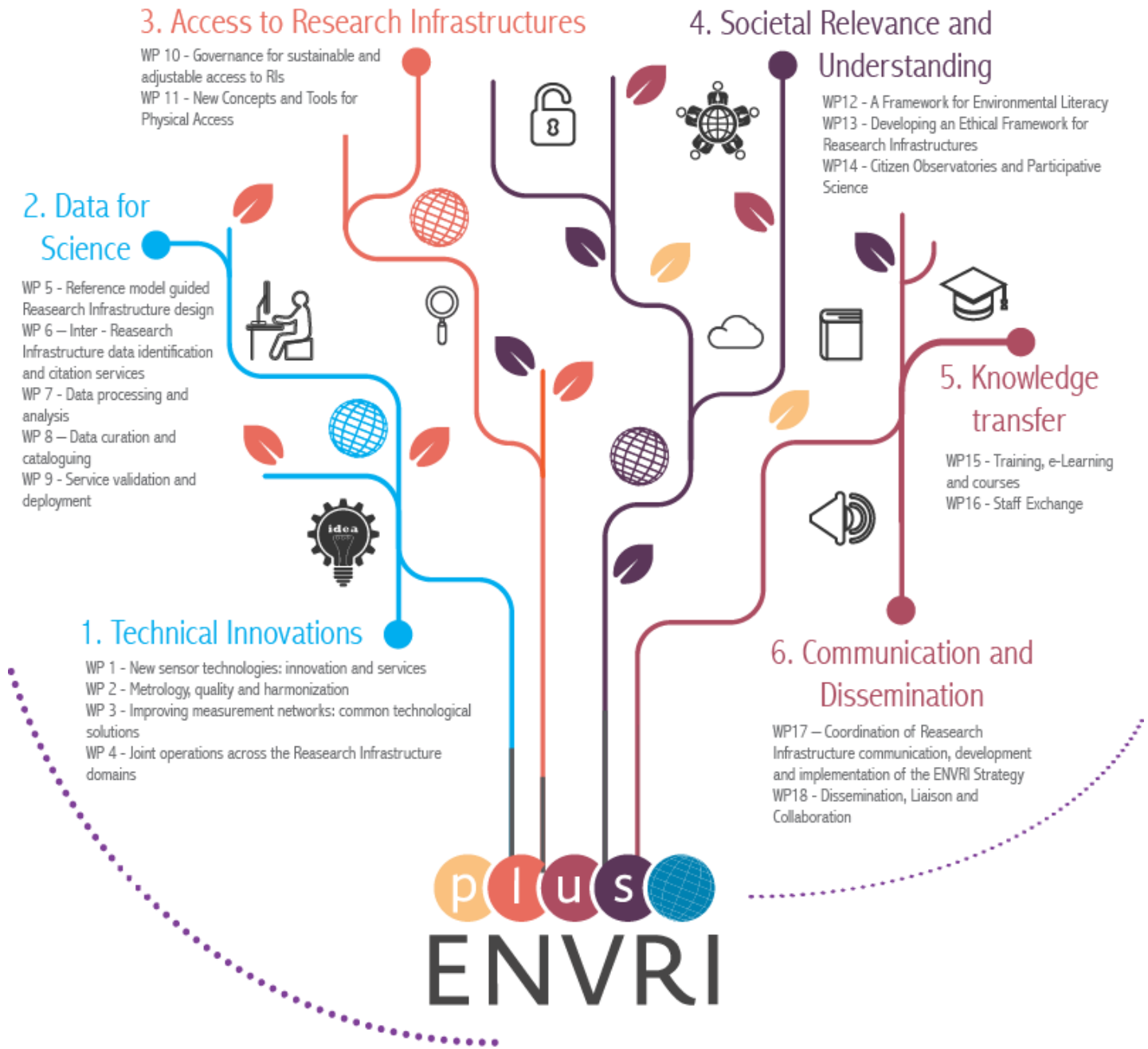


ENVRI

Environmental Research Infrastructures Providing Shared Solutions for Science and Society



21 Research Infrastructures (10 ESFRIs)


3. Access to Research Infrastructures
WP 10 - Governance for sustainable and adjustable access to RIs
WP 11 - New Concepts and Tools for Physical Access
4. Societal Relevance and Understanding
WP12 - A Framework for Environmental Literacy
WP13 - Developing an Ethical Framework for Reasearch Infrastructures
WP14 - Citizen Observatories and Participative Science
2. Data for Science
WP 5 - Reference model guided Reasearch Infrastructure design
WP 6 – Inter - Reasearch Infrastructure data identification and citation services
WP 7 - Data processing and analysis
WP 8 – Data curation and cataloguing
WP 9 - Service validation and deployment
idea
5. Knowledge transfer
WP15 - Training, e-Learning and courses
WP16 - Staff Exchange
1. Technical Innovations
WP 1 - New sensor technologies: innovation and services
WP 2 - Metrology, quality and harmonization
WP 3 - Improving measurement networks: common technological solutions
WP 4 - Joint operations across the Reasearch Infrastructure domains
6. Communication and Dissemination
WP17 – Coordination of Reasearch Infrastructure communication, development and implementation of the ENVRI Strategy
WP18 - Dissemination, Liaison and Collaboration
plus
ENVRI

ENVRI plus

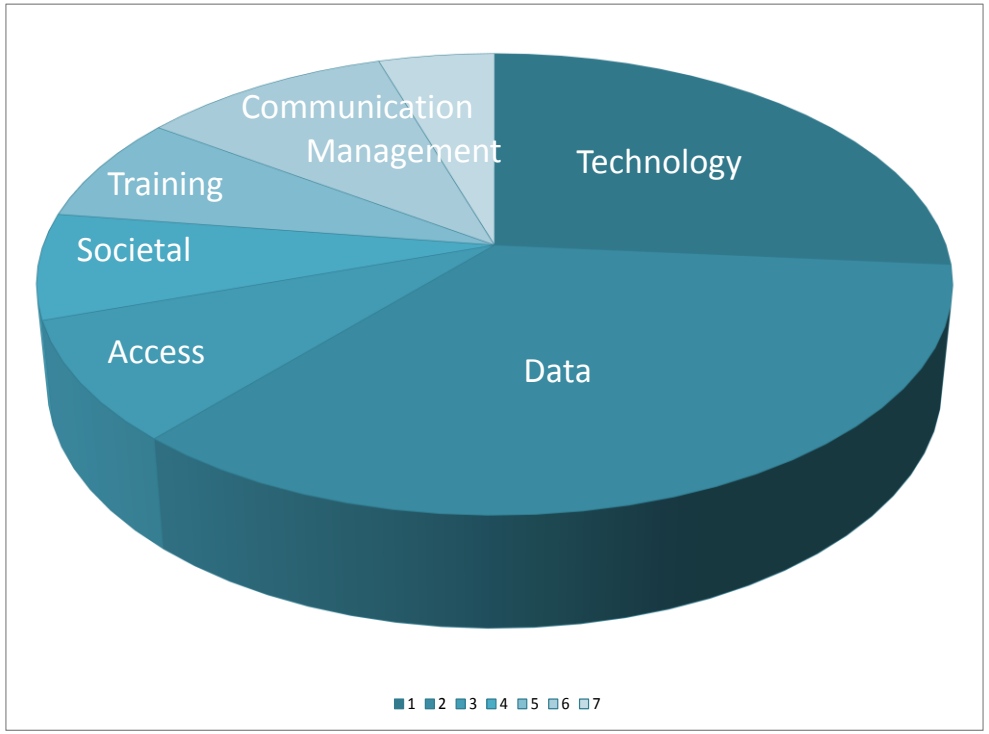
Environmental Research Infrastructures Providing Shared Solutions for Science and Society

Coordinator Werner Kutsch, ICOS,
co-coordinator Paolo Laj, ACTRIS

15 M € budget

Project duration 2015 – 2019

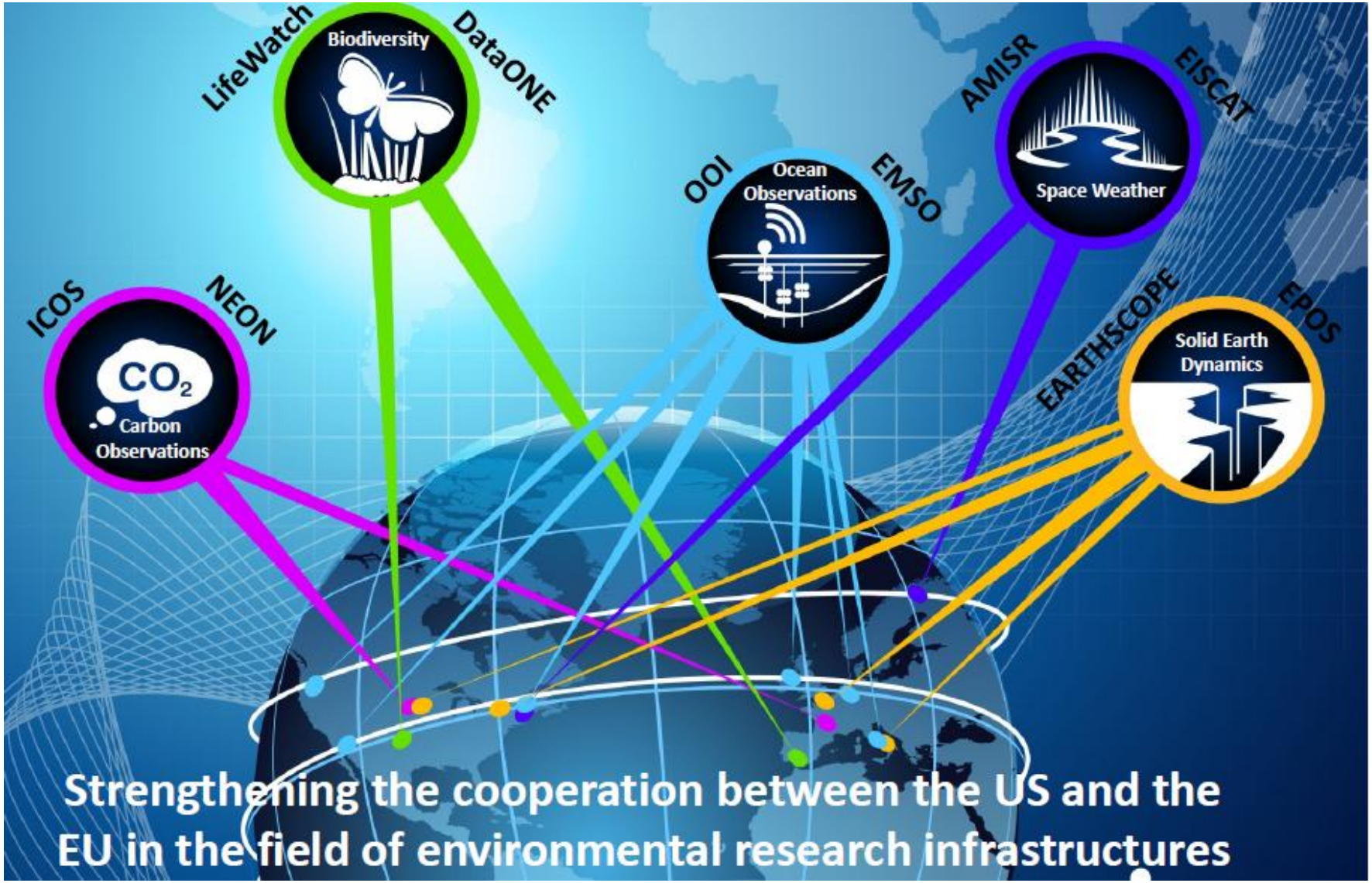
4 Domains (Atmosphere, Biosphere, Marine, Solid Earth)



BEERi - Board of European Environmental Research Infrastructures

Open Research Infrastructure Community platform

COOPEUS


LifeWatch
Biodiversity
DataONE
AMISR
EISCAT
Space Weather
OOI
Ocean Observations
EMSO
ICOS
NEON
CO_2
Carbon Observations
EARTHSCOPE
EPOS
Solid Earth Dynamics
Strengthening the cooperation between the US and the EU in the field of environmental research infrastructures

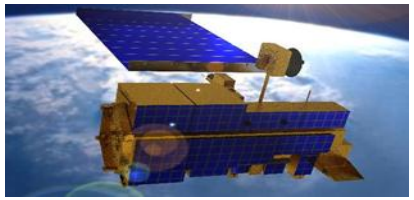
Observation for Climate and Air Quality, A Three-way Street:
Satellites provide context, ***Ground-based*** provides details, & ***Models*** complete the picture

Ground-based

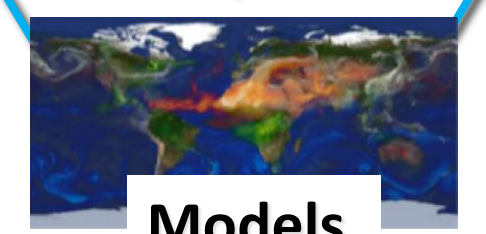
4D targeted chemical & microphysical detail point-location time series

CURRENT STATE
- **Initial Conditions**
- **Assimilation**

Satellites



frequent, global *snapshots*;
aerosol amount & aerosol type maps,
plume & layer heights

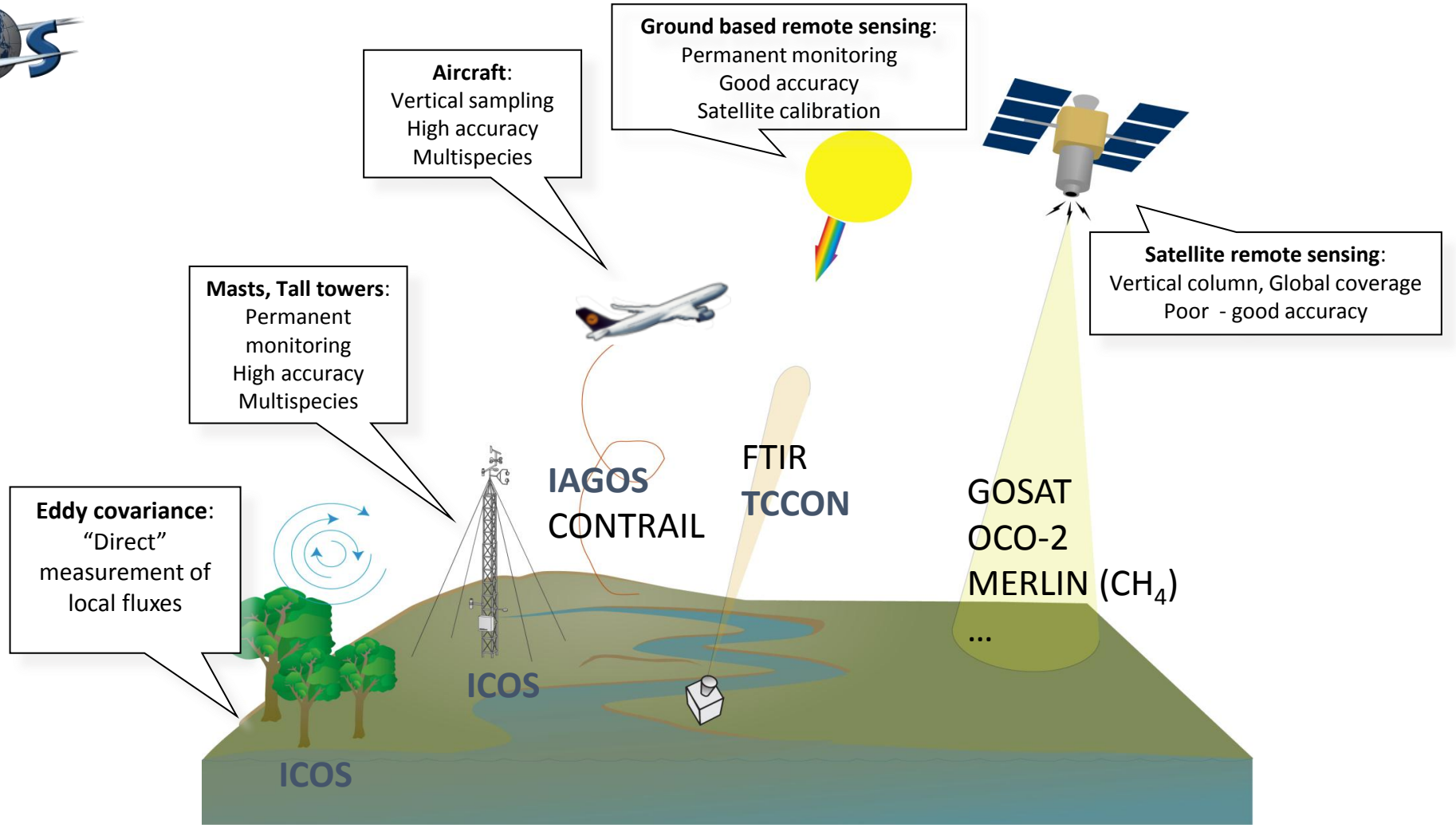


Models

space-time interpolation,
calculation and prediction

MODEL VALIDATION
- **Parameterizations**
- **Climate Sensitivity**
- **Underlying mechanisms**

Carbon and GHG observations



[courtesy J.D. Paris]

- EPOS has a community involved in integrating satellite data observations for solid Earth science, e.g. ESA collaboration in EPOS Implementation Project and on ESA exploitation platform

- EISCAT data are important for ionospheric and magnetospheric spacecraft missions, EISCAT contributes to space weather studies to provide input to increase the validity of space weather models

- Marine RIs provides ground-based information on ocean observations

- Terrestrial ecosystem RIs, such as ANAEE, LTER and LifeWATCH contributions to land observations

How the collaboration among ground-based research infrastructures contributes to the open science?

User requirements for open science

- open, fair and transparent access to large volumes of high-quality data
- easy to combine/merge large volumes of complex data from various data sources and disciplines
- availability of open analysis tools, computing facilities/services
- easy to reach user support services
- provision of data storage for user’s data results (data management plans, reproducibility)

Data provision requirements

- attribution and traceability (single data provider)
- coordinated data management (RI level)
- metadata and workflow descriptions (RI level)
- common reference model / agreed framework (RI cluster level)
- brokering systems for federated data (RI cluster level)

Open Science requires institutional framework (cores)

Attribute	Network	Research Infrastructure
Science / content	scientists, creators, inventors	scientists, managers, directors, delegated
Design flexibility	flexible, creative	fixed, baselined
Fabricated by	in-house craftwork, "make"	industrial approach, "buy"
Team		ers, accountants,
Governance		lders/owners)
Project process	internal	iterative
Success defined by	scientists, creators, inventors, peers	scientists, managers, reviewers, sponsors, peers
Funding	short-term, project-based	long-term, member states, business model with financial plan

Sustainability
Connection to user communities

New data acquisition systems
+ data management

Virtual Research Environments
(computing services + remote access, collaboration with e-infrastructures, e.g. clouds)

Virtual Research Environments
(internal and external tools)

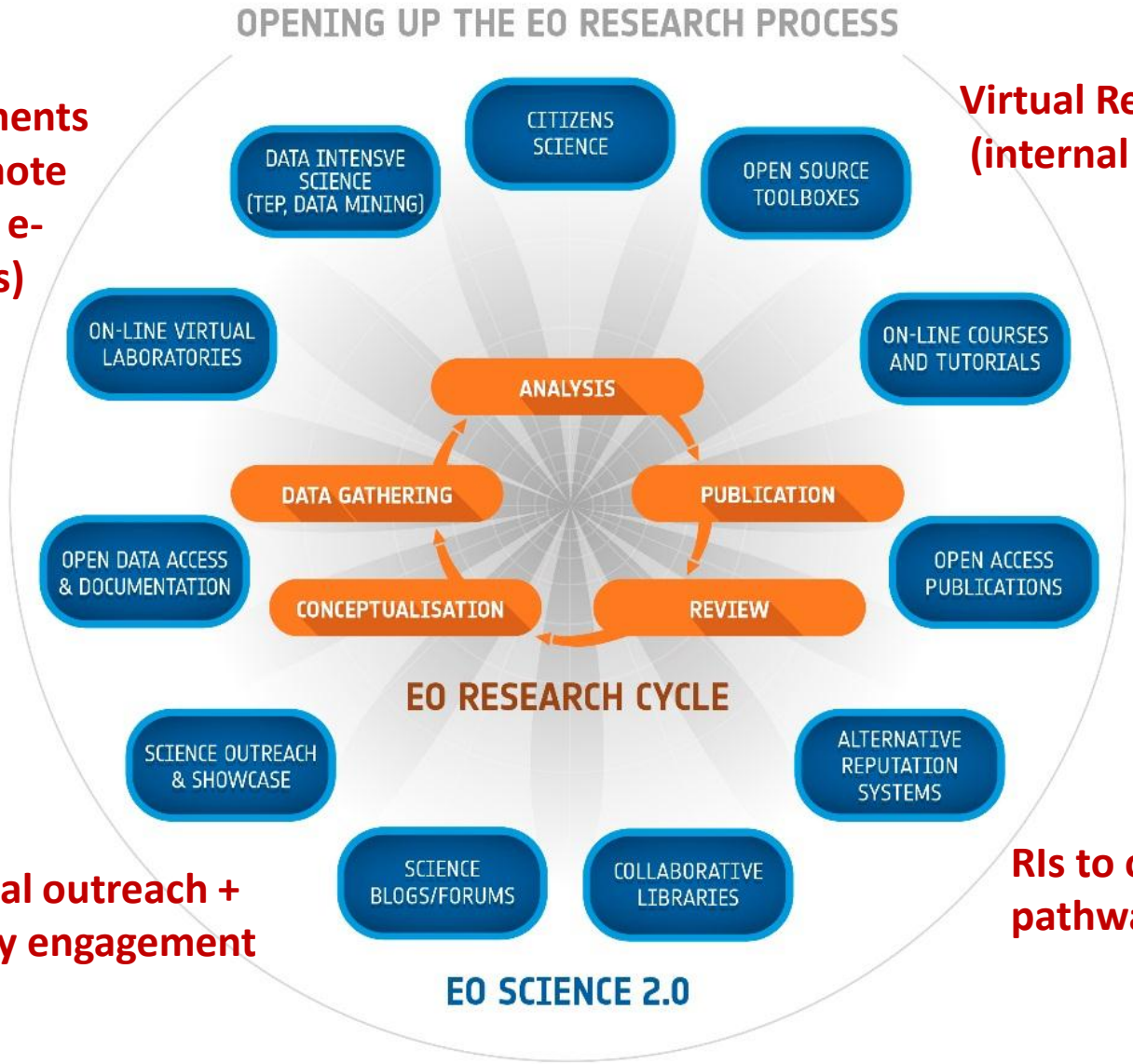
User training

RI data provision
data portals,
brokering systems

Work on common data citations and data publications

Professional outreach + community engagement activities

RIs to offer novel career pathways



Environmental Research Infrastructures Providing Shared Solutions for Science and Society

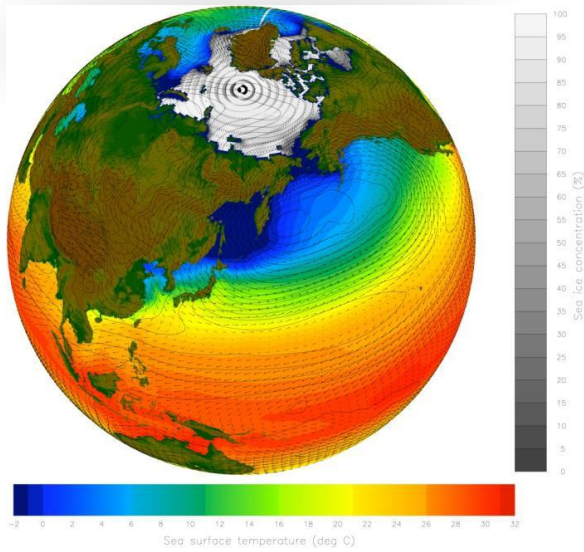
ENVRIplus Coordination Office envriplus-coordination@helsinki.fi

Find ENVRIplus on:

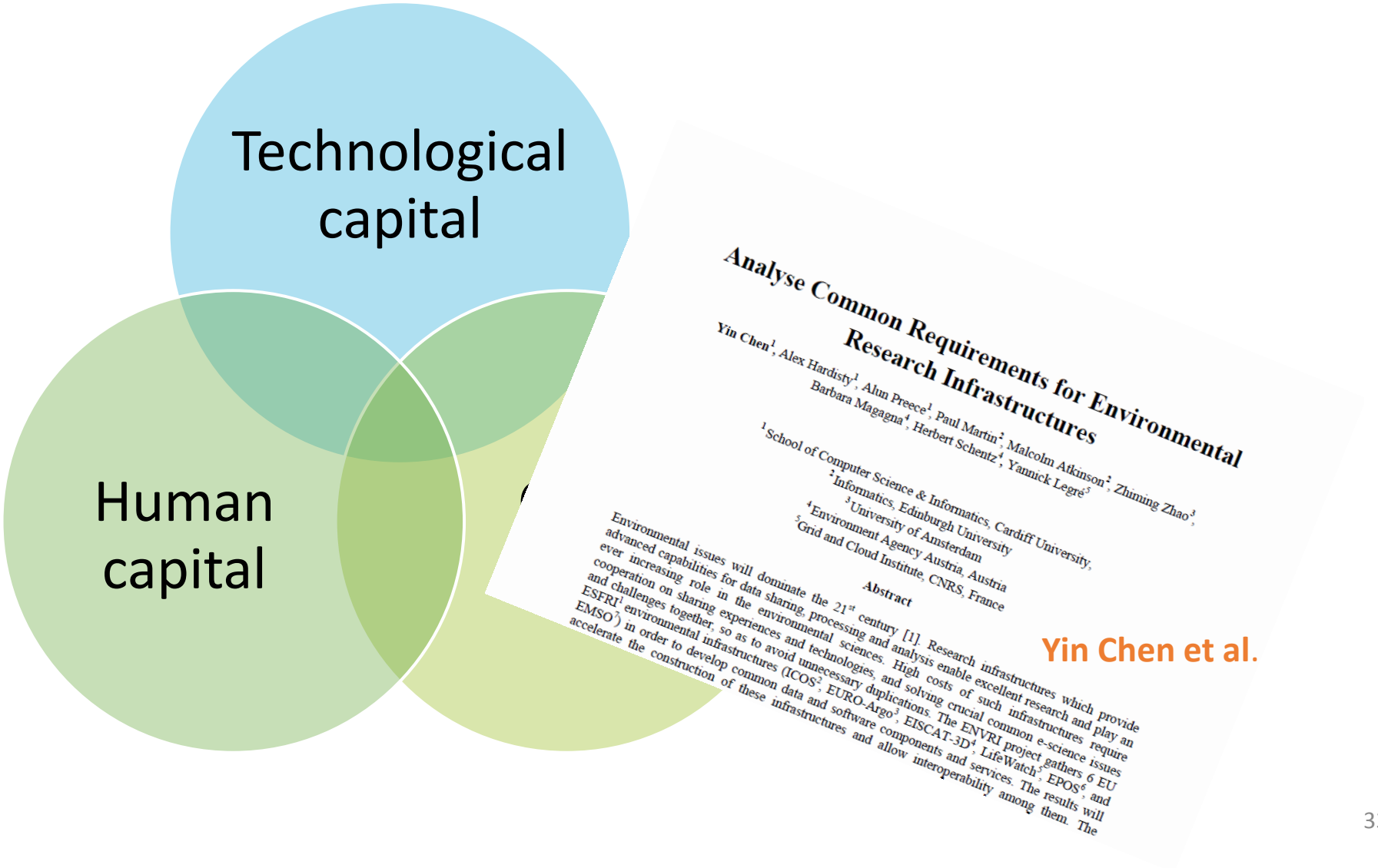
- Twitter - @ENVRIplus
- Facebook page – ENVRIplus
- LinkedIn Group – ENVRIplus

Website: **www.envriplus.eu**

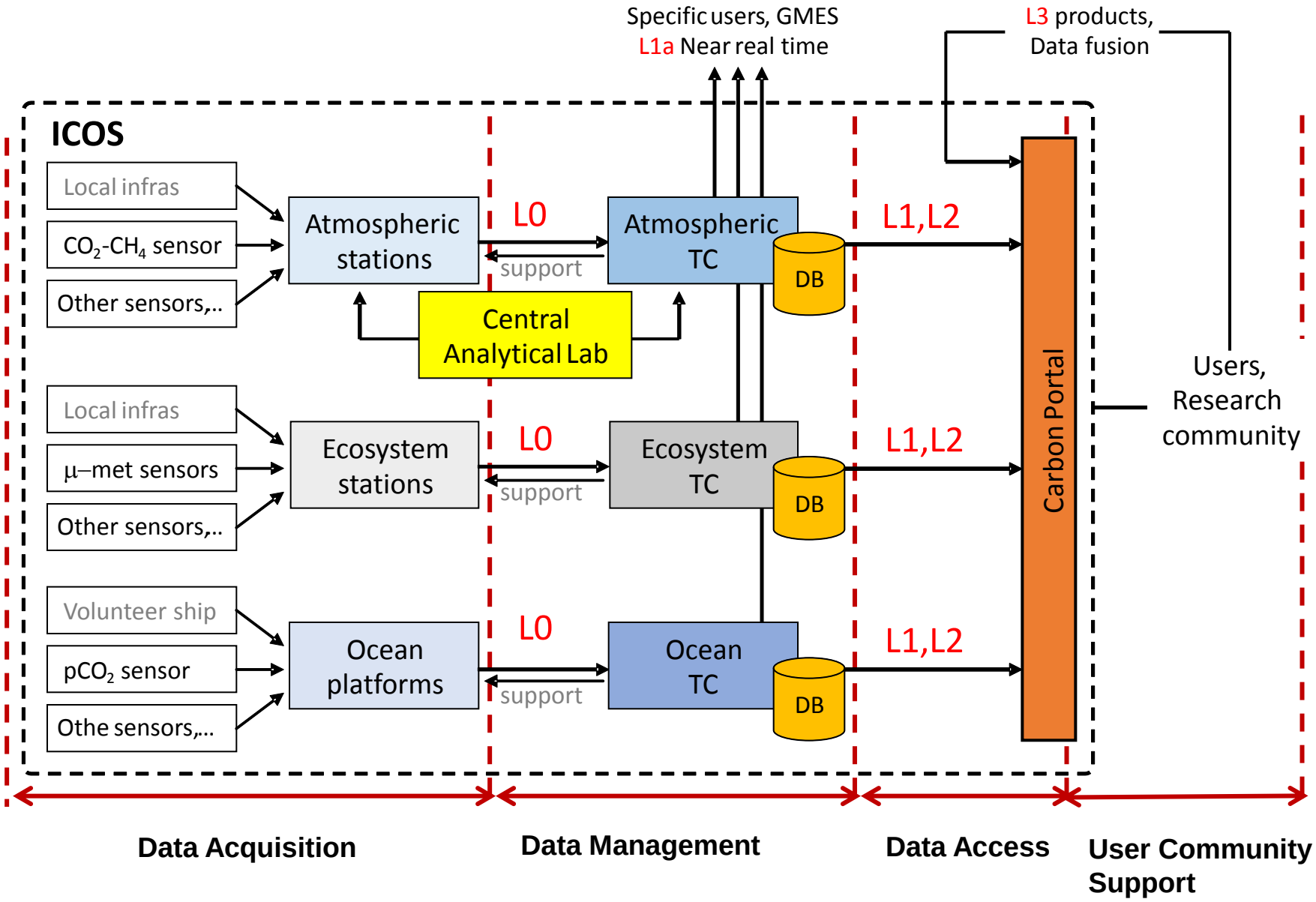
observations – experiments - models



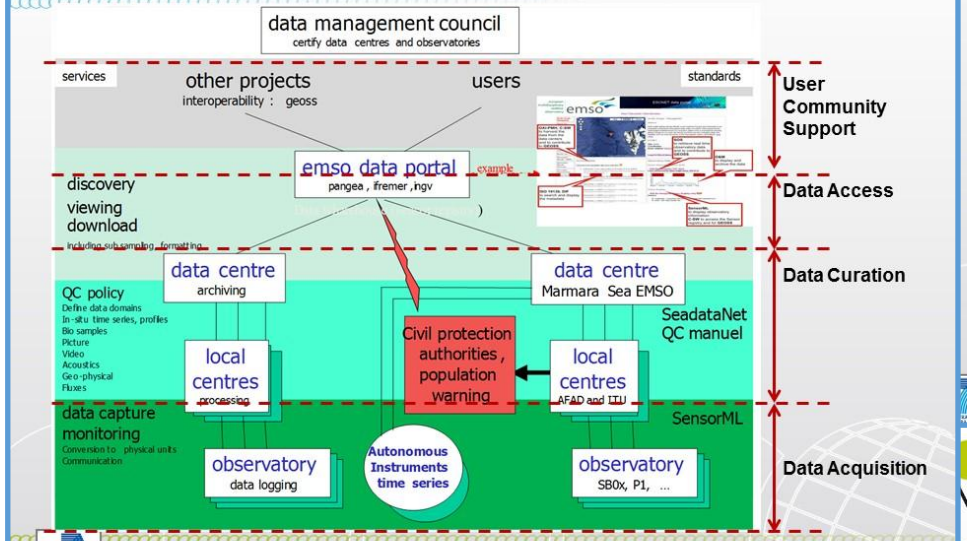
Building blocks of the interoperability



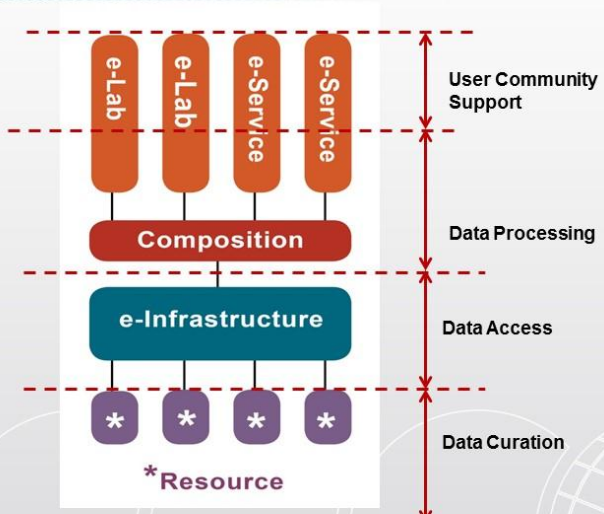
ICOS Architecture



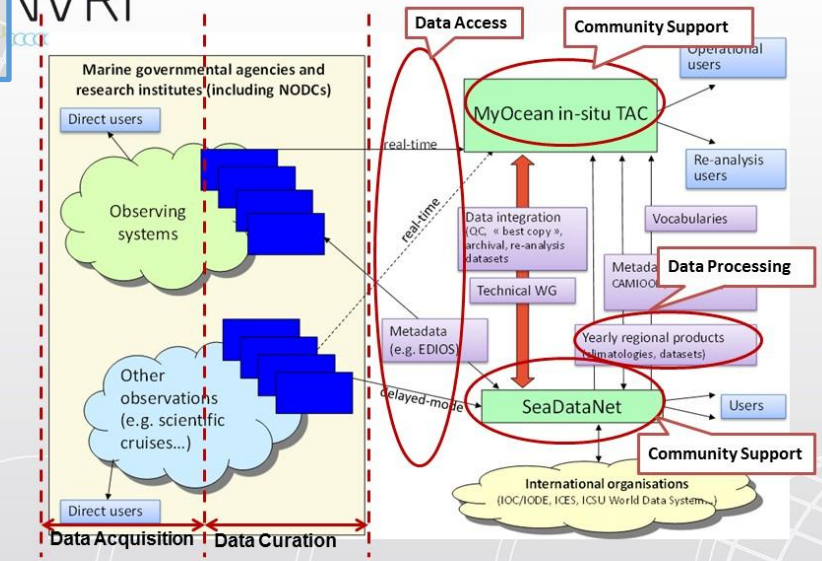
ENVRI Analysis: EMSO Architecture



ENVRI Analysis: LifeWatch Architecture

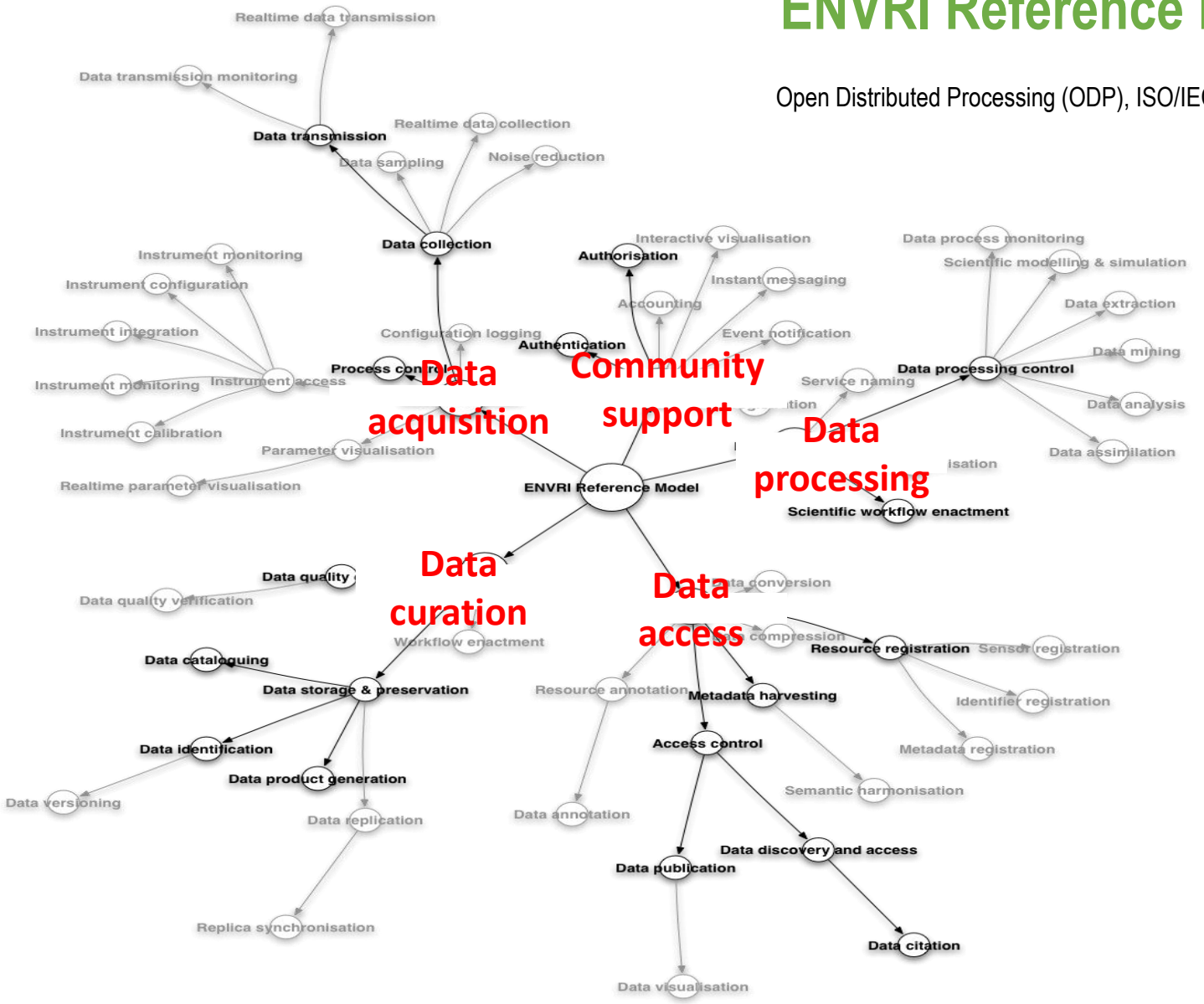


Analysis: EURO-Argo Architecture



ENVRI Reference Model

Open Distributed Processing (ODP), ISO/IEC standard



Building blocks of the interoperability