

Wouldn't it be nice if ...



- ✓ ... all my data, tools, and resources were available in one place?
- ✓ ... I didn't spend 50% of my project resources trying to access (EO) data?
- ✓ ... ICT (storage, compute, and network) was completely free?
- ✓ ... my funding scheme fit pay-per-use (instead of capital investment)?
- ✓ ... most of my tools were available as open source?
- ✓ ... I could make my stuff available to others while retaining IPR?
- ✓ ... access to data or resources didn't depend on my nationality, affiliation, or participation in a particular project?
- ✓ ... I could have access to people and their knowledge in a collaborative setting?
- ✓ ... I didn't need to be an ICT wizard or instrument expert to integrate stuff into my research or application?
- ✓ ... I could collaborate easily with colleagues, also in other disciplines?
- ✓ ... I could rapidly test out a new idea? With my peers? And publish the result?
- ✓ ... I could get fast, crowd-sourced validation of my results?
- ✓ ... I could use my own data and tools with everything else?

ESA EO Ground Segment Evolution Action on Thematic Exploitation Platforms



geohazards
tep



polar
tep



coastal
tep



hydrology
tep



urban
tep



forestry
tep

A presentation to CEOS WGISS-42
Frascati, September 22, 2016



thematic exploitation platform

[Sveinung.Loekken | Gordon.Campbell | Salvatore.Pinto | Philippe.Bally]@esa.int

Background, Concept, Planning Overview

Where we are

Where we're going

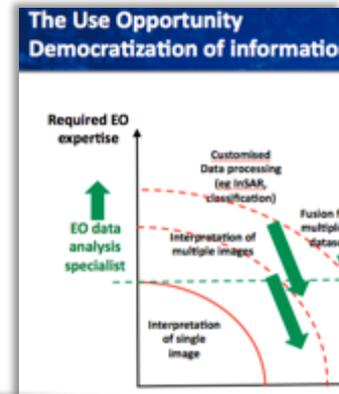
Background



Data on the state of the planet growing in volume, velocity, variety, and value

Disruptive technologies advancing at breakneck speed

- Sharp change in scenarios for data exploitation – **new challenges, new opportunities**
- ESA Ground Segment Evolution Strategy: develop **complementary operations concepts, including exploitation platforms**



The Innovation Opportunity - innovation from Earth Science v other disciplines

58. The Innovation-science link by technology area, 2001-11



Virtual research environments, exploitation platforms, Open science, Science 2.0, crowdsourcing, citizen science, citizen observatories, Education 2.0, Open innovation, Incubators, "Game of Drones", mining, Data cubes, IPR, Semantic technologies, AI, Machine learning, Human computation ... just to name a few

Commoditization of ICT capabilities, Cloud computing, Digital marketplace "from LPs to Spotify in 30 years", App stores, ubiquitous invasive social networks

The Data Challenge

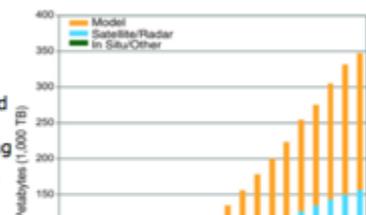
To handle (and to afford) the increasing **volume, velocity, and variety** of data required for data-intensive exploration while considering also its **veracity and value**

Climate data example

50 PB estimated 'available' by 2016; 350 PB by 2030
 "Climate data are dramatically increasing in **volume and complexity**, just as the users of these data in the scientific community and the public are rapidly increasing in number"

Ultimate Data Challenges in the 21st Century

Climate data are dramatically increasing in volume and complexity, just as the users of these data in the scientific community and the public are rapidly increasing in number. A new paradigm of more users, user-friendly data access is needed to ensure that society can reduce vulnerability to climate variability and change, while at the same time exploiting opportunities that will occur.



Volume	Velocity	Variety	Veracity	Value
Data at Rest	Data in Motion	Data in Many Forms	Data in Doubt	Data into Money
Terabytes to exabytes of existing data to process	Streaming data, requiring mseconds to respond	Structured, unstructured, text, multimedia,...	Uncertainty due to data inconsistency & incompleteness, ambiguities, latency, deception	Business models can be associated to the data

Evolving The Ground Segment Ops Concept

One-stop community access

- To data & toolboxes ->
- GEO Geohazards Supersites

Processing on demand, managed user services

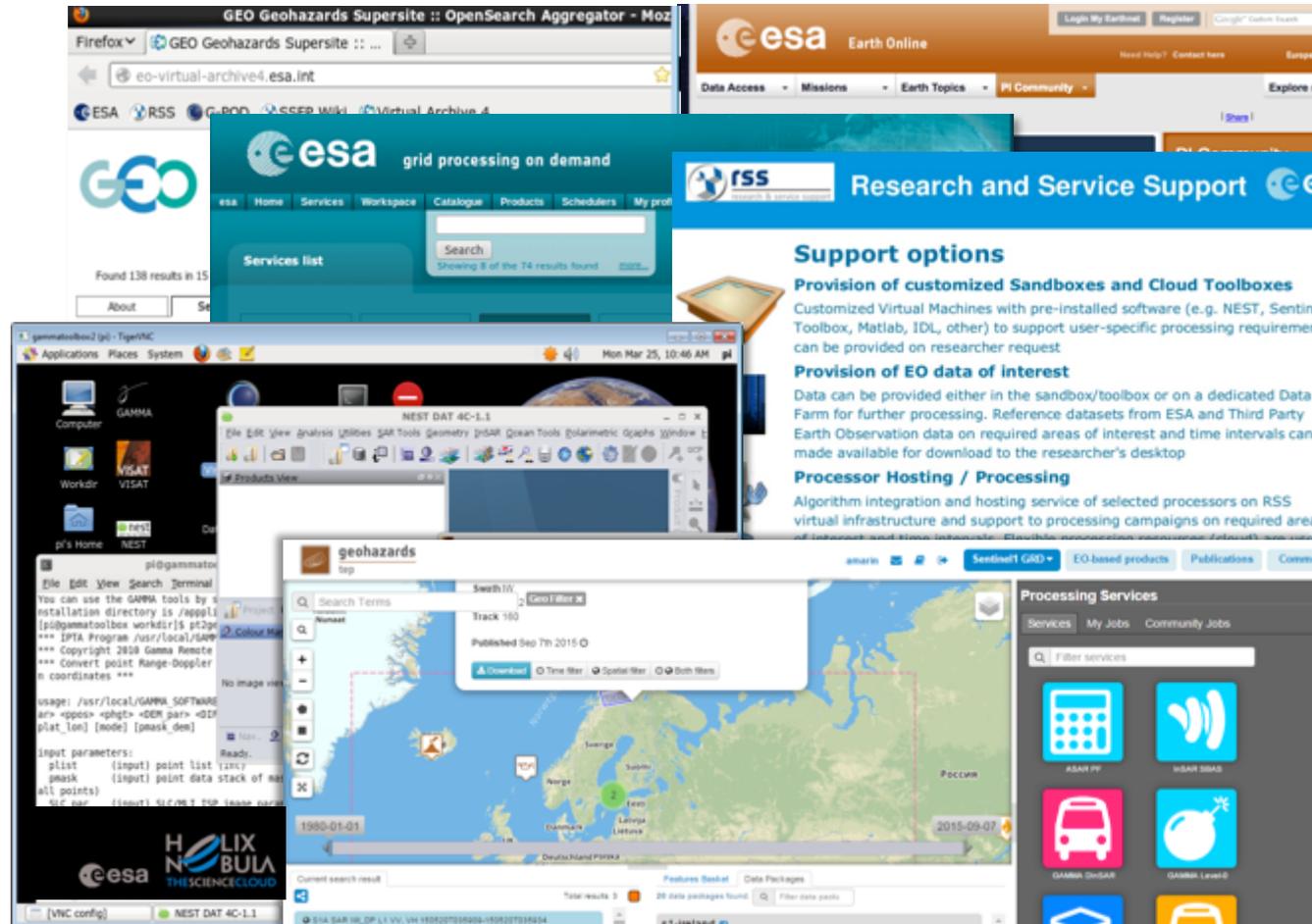
- GPOD & RSS
- Sandboxes, tools and data

Cloud models, Embryonic Virtual Workplaces

- Helix Nebula
- SSEP (Helix Nebula Flagship), EP4SM

Exploitation Platforms

- Refined scenarios
- Pre-operational use
- TEPs (REPs, MEPs...)



So: From distributing data and tools to providing access to all data and the resources required to exploit them, where they are used

- Each step **depends** on the previous
- What is **required to implement changes** as concept evolves (technology, partnerships, programmatics, funding and business models etc.)

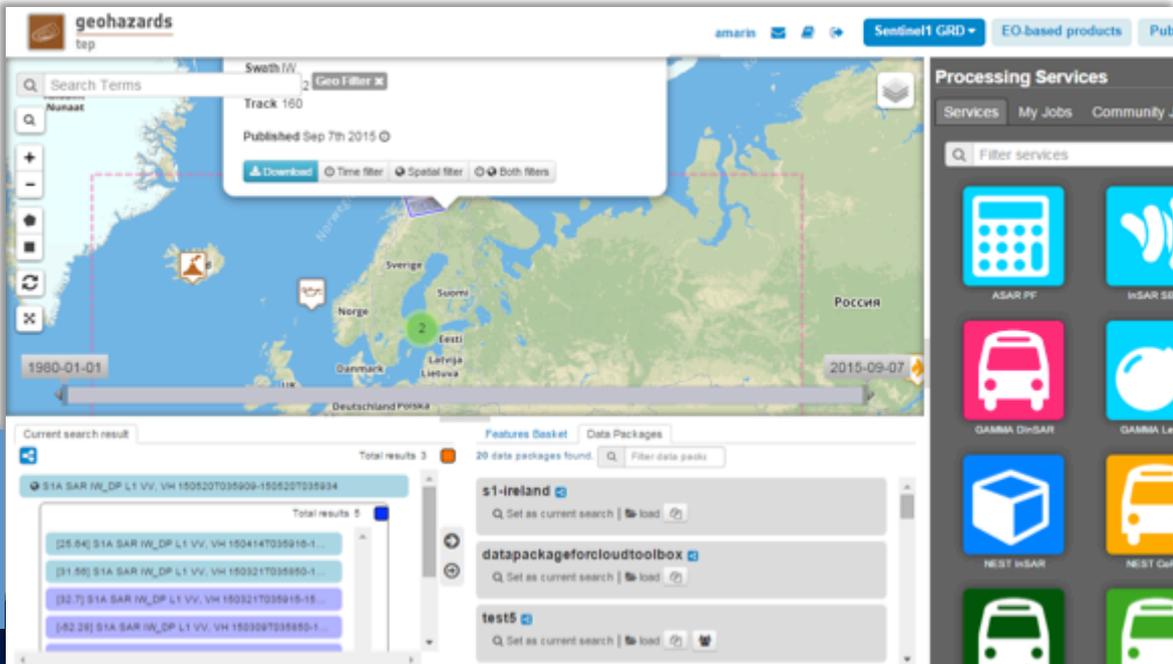
Exploitation Platforms Concept

Exploitation platforms



Users access a virtual, open and collaborative work environment containing the data and resources required, as opposed to downloading and replicating the data 'at home'.

EO and non-EO data, computing resources, collaborative tools (processing tools, data mining tools, user tools...), dev environment, test bench functions, app stores and market place functionalities, communication tools (social network) and documentation, accounting tools to manage resource utilisation ...



Three canonical use scenarios:

- EO data exploitation
- New Service
- New product (including massive processing)

Types of Exploitation Platforms

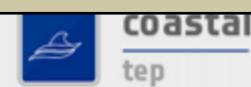
Examples at ESA of different types of Exploitation Platforms:

Thematic Exploitation Platform (TEP) → Focusing on a geophysical theme (e.g. forestry)



thematic exploitation platform

<https://tep.eo.esa.int>



*Under development (2015-2017)
with ESA EOEP-4 funds*

And Food Security starting soon

Regional (multi-thematic) exploitation platform:

→ *Focusing on a regional theme (e.g. TBC Baltic, Black Sea, Alpine ...)*

Planned to be developed with ESA EOEP-5 funds

Technological exploitation platform :

→ *To assess new technologies to be rolled out to the exploitation platforms*

*Planned to be developed and operated with ESA funds,
Could also be shared with national space agencies*

Mission/Sensor exploitation platform (MEP):

→ *Tailored to a particular mission/sensor community (e.g. an Earth Explorer user community)*

e.g. → BIOMASS mission community (exploitation) platform
Proba-V mission exploitation platform

Planned to be developed and operated with ESA EOEP-5 funds

Plethora of Exploitation platforms developed outside ESA context by Member States, Int'l Organisations, Industry, etc

TEPs Planning Overview



Based on Previous Technology Trailblazing in ESA EOP

In step with the emergence of cloud computing, virtualization, hosted processing – GPOD, Frascati Declaration and GSNL -> SSEP ...

And subsequent stakeholder consultations

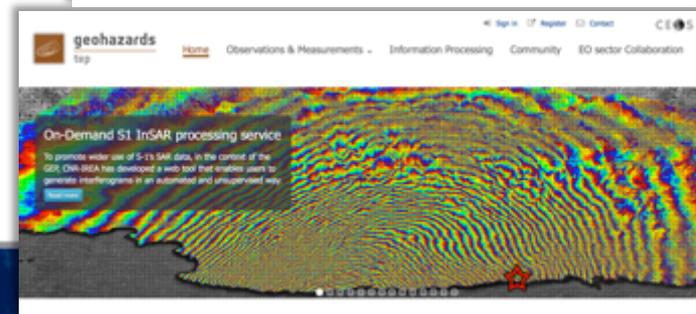
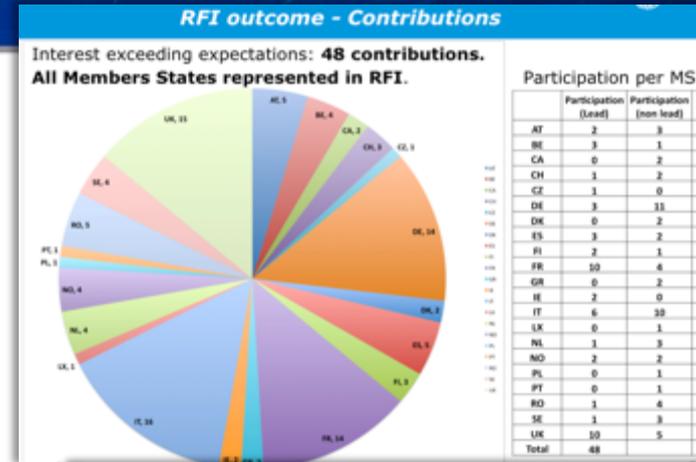
- ☒ Q4 2013, Request for Information – 48 Responses from mixed thematic/ICT/Ground segment consortia – proposing themes, services, ICT capabilities, objectives
- ☒ Q1 2014 industry consultation,

Following TEPs ITT

- ☒ Q2 2014 open ITT

And Projects

- ☒ Q1 2015, start of 5 TEPs projects + geohazards Q3
- ☒ Analysis, design, development of platforms
- ☒ Implementation of a set of thematic Pilot Projects
- ☒ **Pre-operational use from ~Q4 2016 (but varies), for minimum 6 months**
- ☒ **Real-world users; real-world use scenarios**



(Some) Specific Objectives

Short term objectives – addressed in the TEP R&D projects

Step change in capabilities in EO data exploitation

- ☒ Enable what was previously impossible (or at least very difficult)

Engagement

- ☒ Of user communities, institutional stakeholders, industry

Capability Building

- ☒ In user communities – collaborative ICT work environments in exploitation scenarios
- ☒ In industry – development, operations, service delivery on exploitation platforms

Sustainability

- ☒ Persistent, predictable, significant, **sustainable** capabilities for the long term

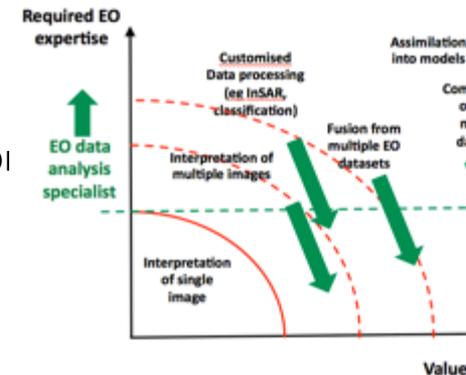
Technology

- ☒ Advance previous activities – SSEP etc: GSP-> TRP-> GSTP -> **EOEP**
- ☒ Evolve ground segment technology and services for new EO data exploitation
- ☒ TRLs and SRLs advanced as required for the platforms
- ☒ Open source architectures and components facilitating future dev.

So not really

✓ *Results in the very short term*

✓ *The 'killer app' for Europe*



Start of longer term activities with wider, longer term European objectives, to unlock strategic/commercial value of EO data on European footing

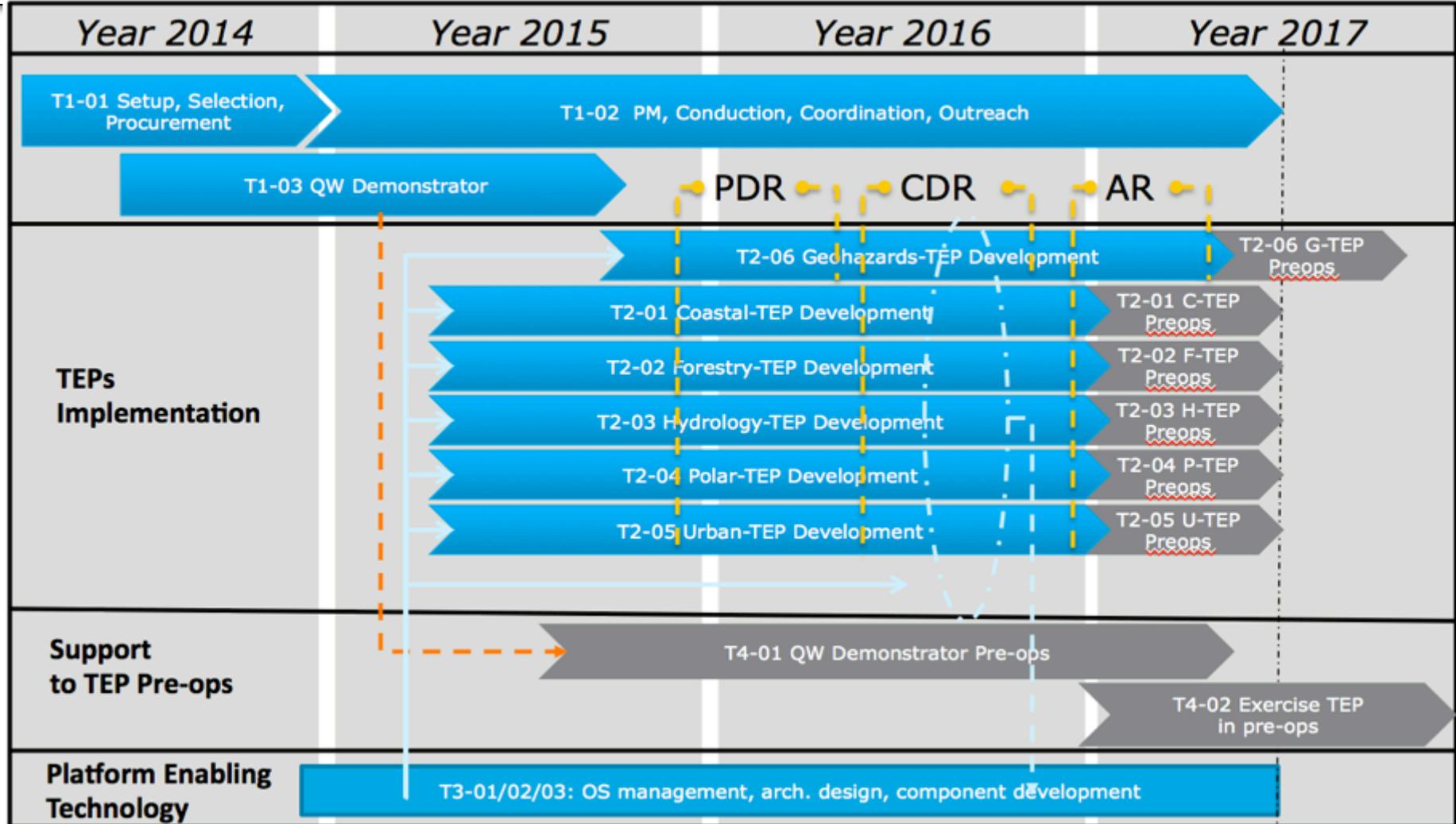
Exploitation Platforms offer multiple advantages as they enable:

- ✓ **Rapid data access** – processing the data directly without downloading
- ✓ **Full focus on exploitation** – avoid spending time on ICT and data sourcing
- ✓ **Synergistic use of data** – different EO data sources available in one virtual environment
- ✓ **Community building** – fostering a spirit of resource- and knowledge sharing
- ✓ **Rapid prototyping**, benchmarking, and deployment of algorithms – PaaS
- ✓ **Automated data processing framework** – allowing generation of products also for less technically sophisticated users
- ✓ **Replicability of scientific results**; traceability of workflow and processes – trail-blazing the new generation of scientific publications
- ✓ **Cost-effective approach to scalable ICT resources** – capitalizing on economy of scale through infrastructure pooling
- ✓ **Development of new business/funding models** – i.e. “data rental”, pay-per-use

Background, Concept, Planning Overview

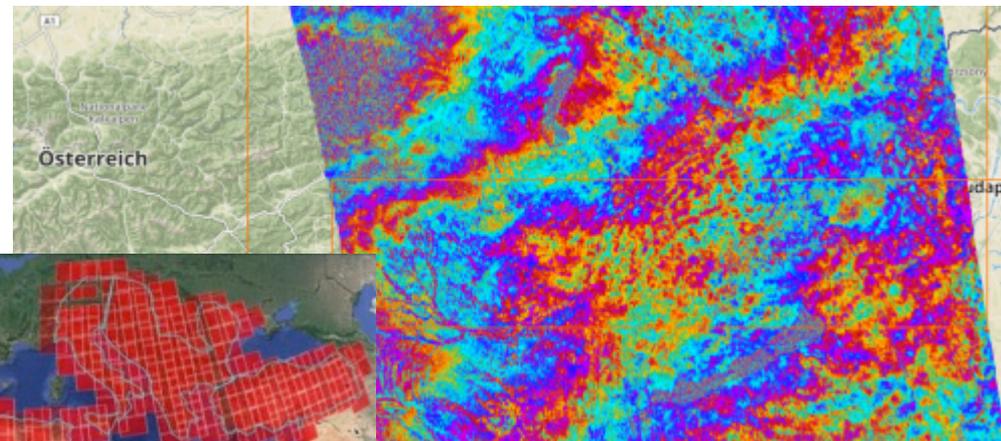
Where we are

Where we're going



Where we are – Step Changes enabled

- ❏ Some real step enablers under development for now based on enhanced processing
 - ❏ Coastal TEP – High resolution WQ parameters on a weekly basis (S2-S3 Fusion)
 - ❏ Geohazards TEP – Integration of parallel InSAR processing chains and InSAR data
- ❏ No developments as yet linked to multi-sensor fusion or other capabilities



Where we are – Engagement

☒ Several TEPs have concrete engagement with large stakeholder communities:

☒ Coastal TEP – Future Earth Coasts, IMBER..

☒ Geohazards TEP – National Geological Surveys

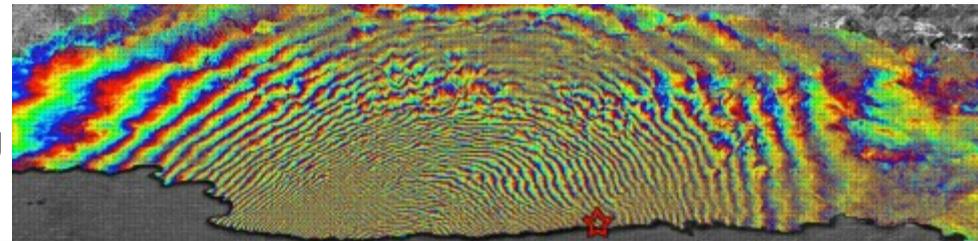
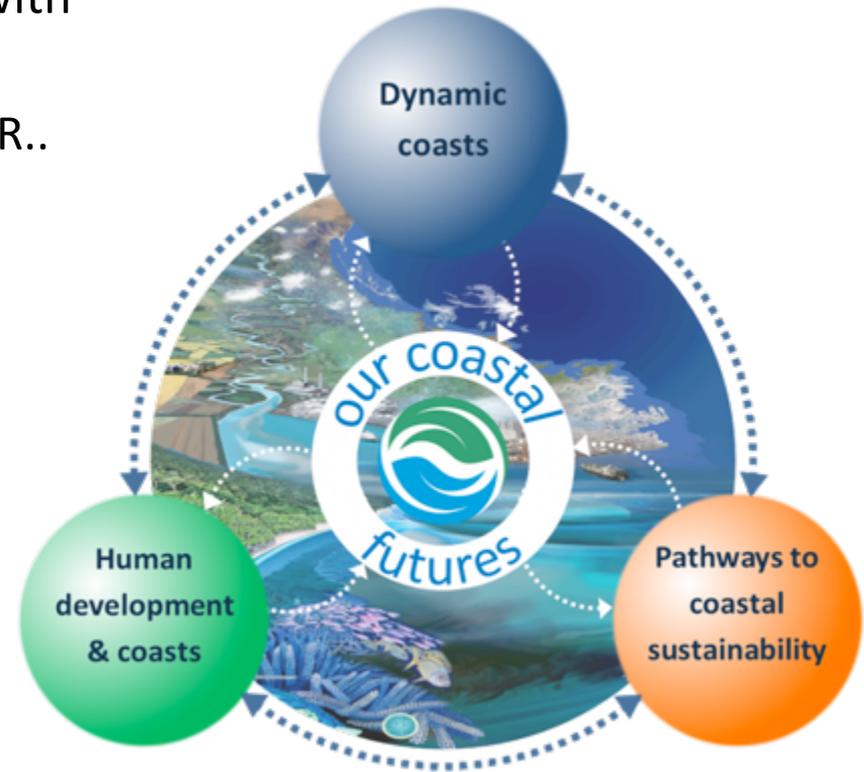
☒ Polar TEP – International Ice Patrol, Sustained Arctic Observing Network (SAON)

☒ Several TEPs already well connected to complementary projects (eg H2020) involving key stakeholders

☒ Coastal TEP - SAFI (H2020)

☒ Geohazard TEP - EPOS (H2020)

☒ Polar TEP – Ice Sheets ECV (ESA CCI), EU PolarNet (H2020)



Where we are – Technology, System & Service

Technology capabilities

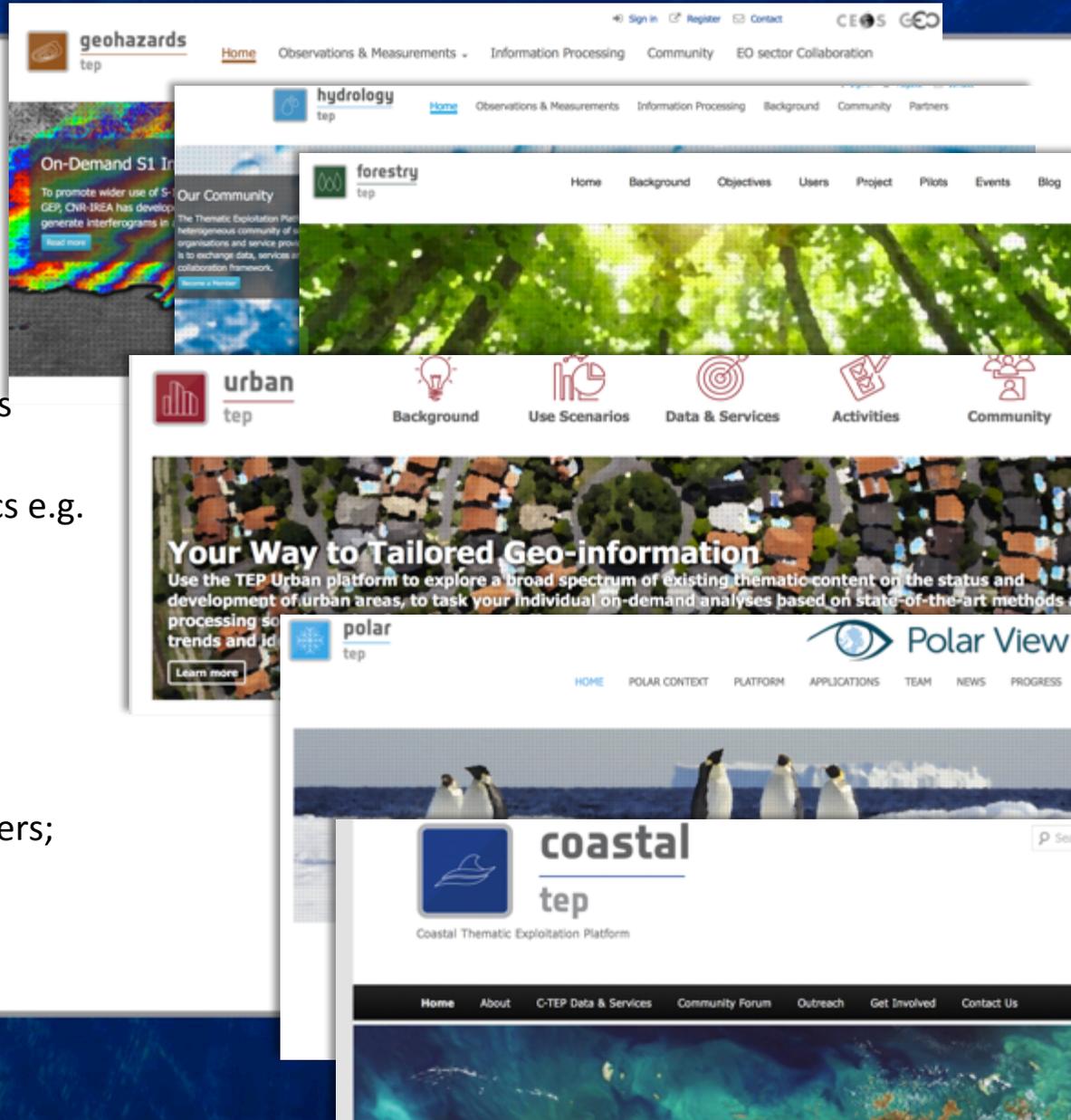
 GSP-> TRP-> GSTP -> EOEP

- Reference model and architecture
- Standardization
- Interoperability
- Reusable open source components
- Advanced Technology and Service ‘Readiness Levels’ on various topics e.g. integrated accounting
- Federated identity management

System and Service

 Tangible results materializing

- GEP in pre-operations with 30+ users; others



Adoption: Examples of GEP *Early Adopters*, Validation Phase started in March 2015 (1)



User organisation	Areas	
Ecole Normale Supérieure de Paris (France)	Etna, Italy and Corinth Rift, Greece	Volcanoes
DLR IMF (Germany)	European tectonic mask	
Altamira Information (Spain)	Test sites on landslides and earthquakes	Earthquakes
ISTerre / Institut de Physique du Globe de Paris (France)	Subduction zones of Latin America, the NAFZ and Tibet.	
INGV Roma (Italy)	Alto Tiberina Fault and Fogo Cape Verde	Landslides
INGV Roma (Italy)	Marmara, East sector of NAFS	
INGV Roma (Italy)	Haiti and West Java	Subsidence

User organisation	Areas
ETH (Switzerland)	
NOA (Greece)	Indonesia
SATIM (Poland)	Asia, N& S America, Indian Ocean
IPGP (France)	
Universidad de Concepcion (Chile)	Southern Andean zone
Obs. Physique du C	
INGV Catania (Italy)	South America active volcanoes and tectonics
Laboratoire de Dynamique Terrestre et Planétaire (France)	
BRGM (France)	French coast subsidence
British Geological S	
AIM CEA (France)	La Reunion
University of Leed	
National Cartographic Center (Iran)	Iran
ESA	
Instituto Geologico y Minero de Espana (Spain)	SouthEast Spain
USGS (USA)	Latin America volcanoes
ESA(Progressive Sy	
CVGHM (Indonesia)	Indonesian and Mexican volcanoes

CNR IREA (Italy)

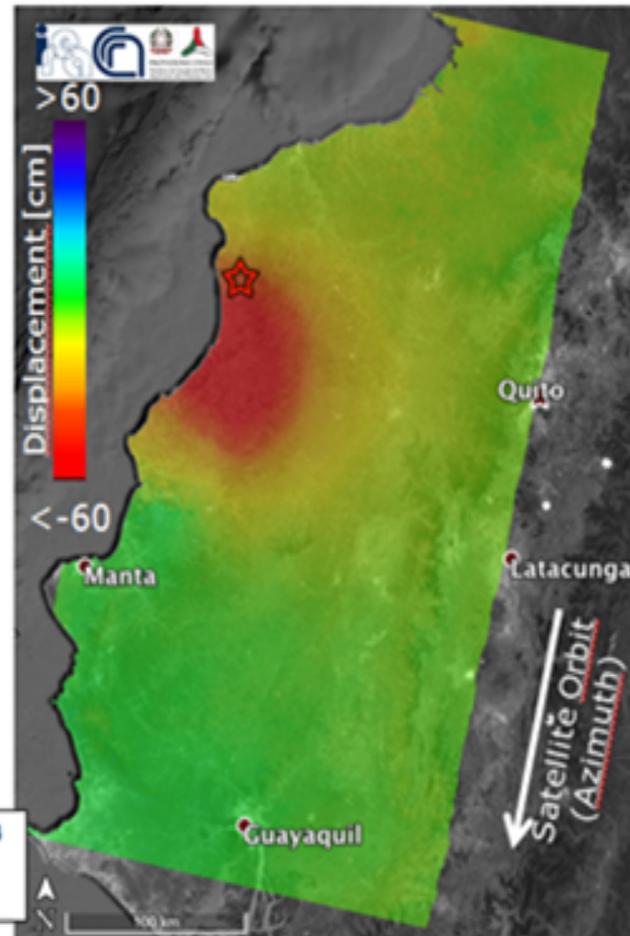
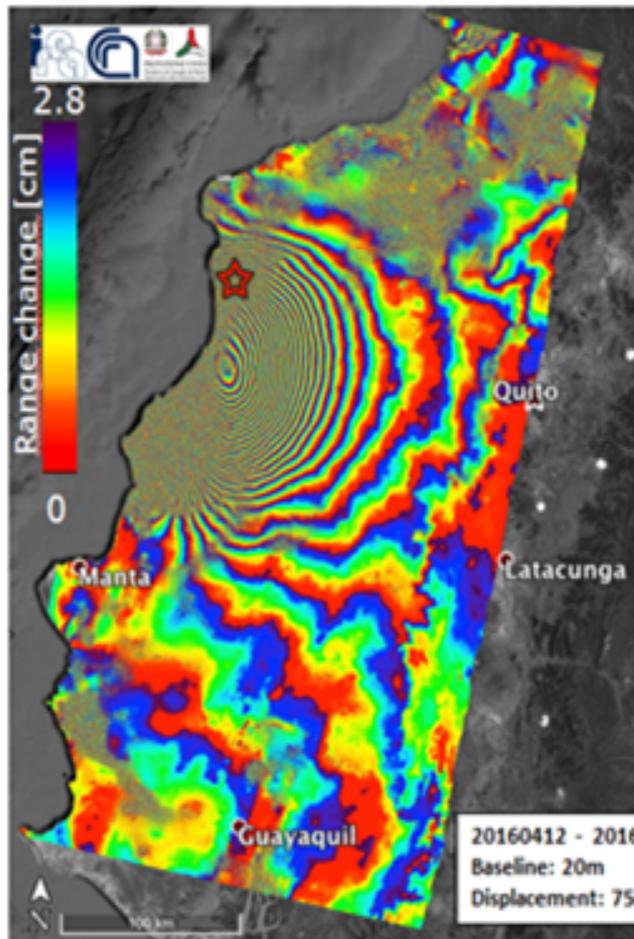
Universita De L' Ac

University College

University of Raba

- 32 users up to early September 2016
- 5 of them being CEOS pilot users (4 Seismic pilot users and 1 Volcano pilot)
- Mainly European users, but also 5 users from Asia (Indonesia and Iran), Africa (Morocco), South America (Chile) and North America (USA).

Example: 2016 Ecuador Earthquake: Sentinel-1 GEP Interferogram & Displacement map by CNR IREA



INTERFEROGRAM AND
DISPLACEMENT MAP
GENERATED BY CNR-IREA,
EXPLOITING COPERNICUS
SENTINEL-1 ACQUISITIONS
OF 12 AND 24 APRIL 2016.

Example of promotion of results on the GEP for the Central Italy Earthquake (1)



[Home](#) [Observations & Measurements](#) [Information Processing](#) [Comm](#)

Center Italy Earthquake

On 24 August 2016, a 6.2 magnitude earthquake struck central Italy. Check Interferograms from GEP community processed just few hours later the acquisition availability.

[View Community](#)

All products generated on GEP for the Central Italy earthquake were gathered under a link on the carousel of GEP's homepage: direct access to results

geohazards tep

Search: Sentinel-1 T117 co-seismic interferogram of Amatrice earth

Authors

- Casoli, Francesco - CNR-IREA
- De Luca, Luca - CNR-IREA
- Zeno, Ivano - CNR-IREA
- Manzoni, Michele - CNR-IREA

DOI: 10.5281/zenodo.62063

Description

Sentinel-1 T117 co-seismic interferogram (unwrap) of Amatrice earthquake (Italy).
Data Type: unwrapped Interferogram (radars)

Example of promotion of results on the GEP for the Central Italy Earthquake (2)

Blog (full archive)

How to publish scientific results on the GEP community map

Cloud services for science Wherever you are working from to generate InSAR products (e.g. in the lab, on the GEP Cloud processing services), you might want to reach-out the Geohazards community active on the GEP Portal. This is made easy as GEP can connect to powerful Cloud services such as...

7 days ago

Example of hosted processing using S-1 data in the aftermaths of the 2016 Central Italy EQ

See the interferogram created by INGV using Sentinel-1 acquisitions of 14 and 26 August. The product was generated using the DIAPASON chain of the French Space Agency, CNES. DIAPASON is one of the hosted processing chains of the GEP. This is one of the many measurements generated by the Community.....

6 days ago

2016 Central Italy Earthquake: GEP publishes EO data collections in support of the CEOS Seismic Pilot

Following the request from INGV, the GEP is providing access to EO data from CEOS Contributors to authorised users. See first collections of ALOS-2 data as well as Sentinel-1A and 1B data. More datasets as Pleiades, Sentinel-2, Radarsat-2, TerraSAR-X and COSMO Skymed will...

6 days ago

2016 Central Italy Earthquake: ESA announcing the first Sentinel-1 based measurements after the Earthquake

On 24 August, an earthquake struck central Italy, claiming at least 290 lives and causing widespread damage. Satellite images are being used to help emergency aid organisations, while scientists have begun to analyse ground movement. The Italian peninsula is prone to earthquakes owing to the...

7 days ago

2016 Central Italy Earthquake: GEP publishes EO data collections in support of the CEOS Seismic Pilot

gpe-blog



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Following the request from INGV, the GEP is providing access to EO data from CEOS Contributors to authorised users. See first collections of ALOS-2 data [\(1\)](#) as well as Sentinel-1A and 1B data [\(2\)](#). More datasets as Pleiades, Sentinel-2, Radarsat-2, TerraSAR-X and COSMO Skymed will follow.

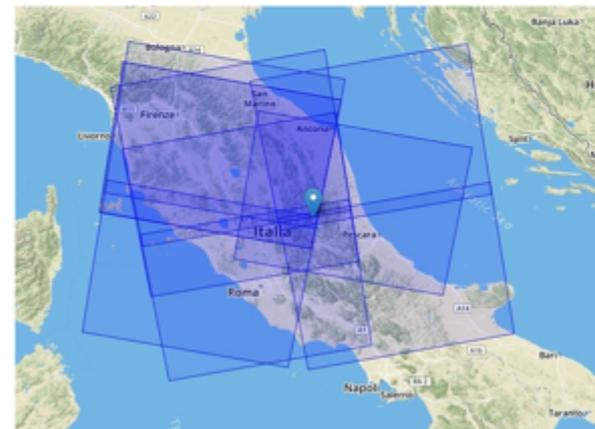


Figure 1. Footprints of the «2016 Central Italy EQ - Sentinel-1» data package.

A number of posts were published on the GEP Blog concerning CEOS data collections, first products generated by CEOS Seismic pilot team etc.

Background, Concept, Planning Overview

Where we are

Where we're going

Beyond the platforms

→ Towards the 'Network of Exploitation platforms' – EO Innovation Europe

Some relevant results

- EP reference model and common conceptual architecture; reusable open source components; early solutions for some lower-TRL elements (e.g. integrated accounting); federated identity management; recommendations for standardization; refined cloud-based operations concepts ...
- Capability development in industry, and in user communities
- **Sustainability analysis and requirements**; embryonic partnership agreements with ICT and data providers
- **Recommendations and requirements for data and ICT partnerships**, funding models, and service levels

Platform concept widely adopted – but synergy is required, ICT & data access, partnerships ...

From single platforms to harmonized approach to EO data exploitation – Network of Platforms/ EO Innovation Europe

- 1-stop community data access
- GEO Geohazards Supersites

- Processing on demand, managed user services
- GPOD
- Research and Service Support

- Embryonic Exploitation Platforms
- SSEP (Helix Nebula Flagship)
- EP4SM

- Exploitation Platforms
- TEPs Geohazards, Coastal, Forestry, Hydrology, Polar, Urban, Food security



GS ops concept evolves from distributing data to users to providing access to all data and resources required to exploit them

- Each step depends on the previous
- What is required to implement changes as concept evolves (technology, partnerships, programmatic, funding and business models etc.)

→ Network of Exploitation Platforms
EO Innovation Europe

Where we're going – Programmatic Context

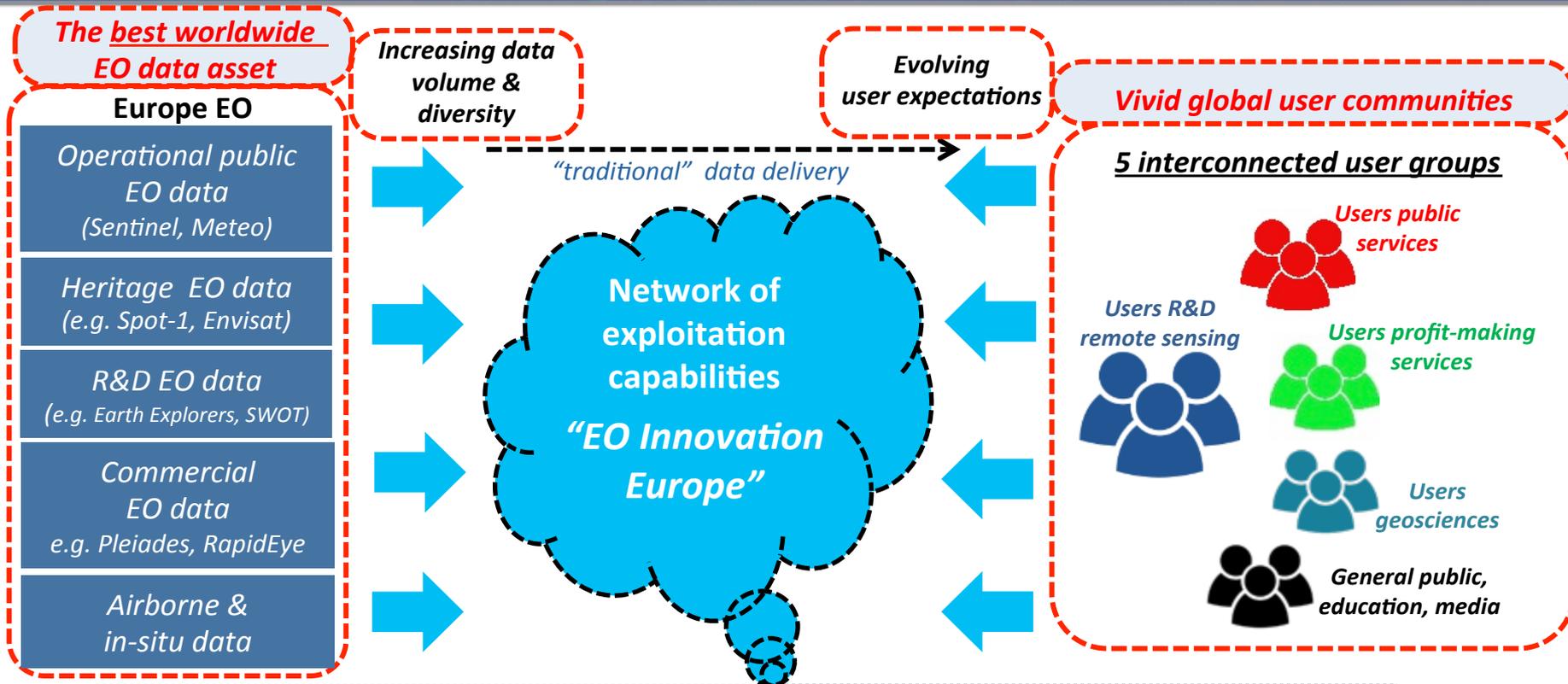
Switching gears: Earth Observation Envelope Programme, Period 5 (EOEP-5, 2017-2021), Element EO Application Platforms - from objectives of a set of ESA R&D projects towards a wider **European objective**, in the context of **EO Innovation Europe**:

“Establish an open, non-monolithic network of EO Application Platforms, fuelled with European EO assets, in coordination with all European stakeholders (EC, Member States, Industry). The network includes data management and service provisioning capabilities, sensor, scientific and applications expertise, within an open collaborative framework and good governance principles.”

- Massively enhance and democratize access and use of EO data
- Respond to needs of authoritative international user communities and downstream industries, consulted systematically and participate in design, implementation and assessment
- Activities designed to complement, seed, cross-fertilize and enrich relevant activities of ESA Member states' national programmes, the European Union , and Copernicus.

EO Innovation Europe

→ a network of exploitation platforms



Objectives of the network concept:

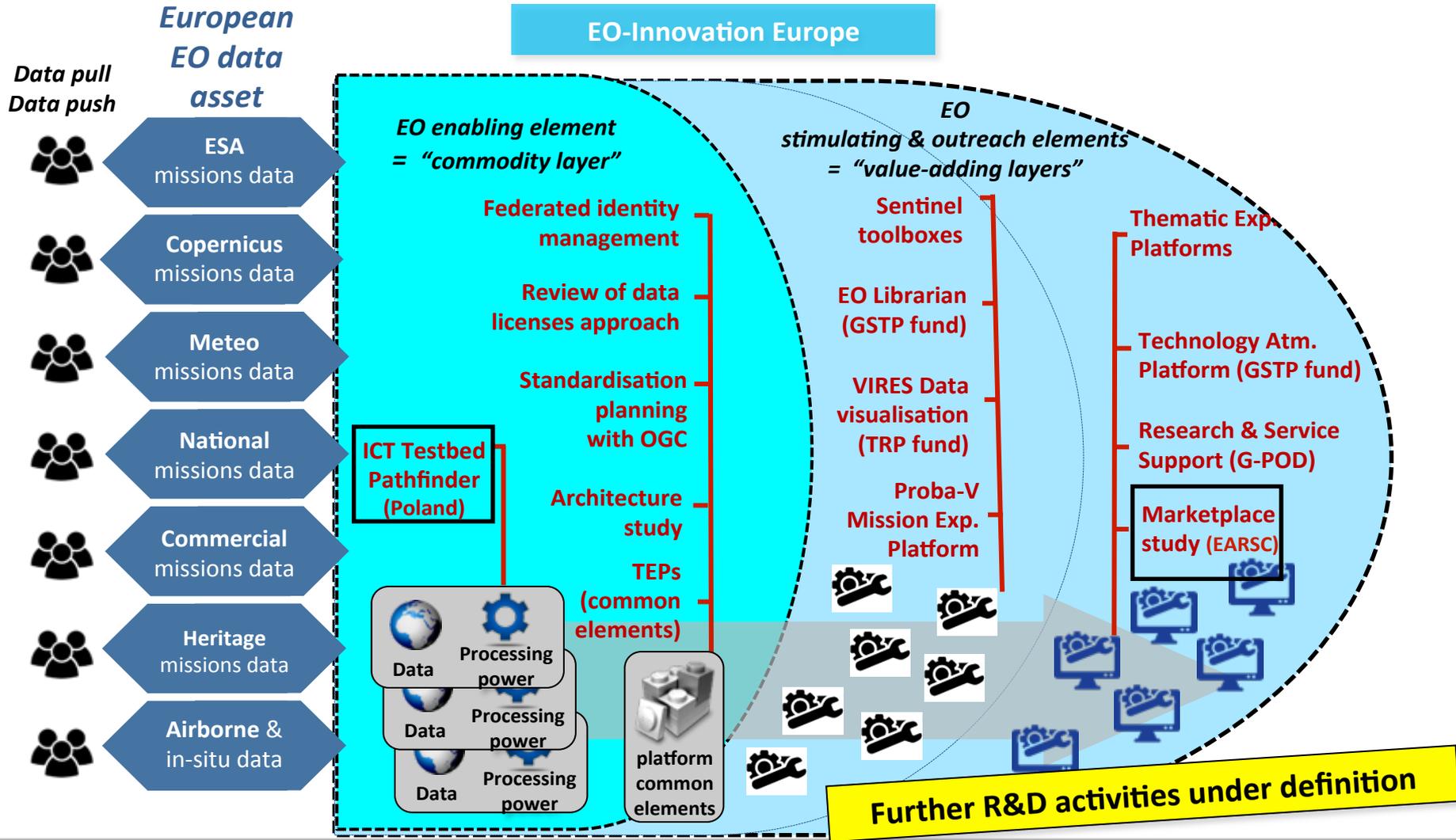
- ✓ Enabling large scale exploitation of EO data
- ✓ Stimulating the innovation with EO data
- ✓ Maximising impact of European EO assets and preserving European independence

How:

- ✓ interconnected platforms around a core enabling element
- ✓ Open to multi-source funding initiatives
- ✓ Common governance rules

EO Innovation Europe

→ map of relevant current R&D pilot activities in ESA



Activities in element address, inter alia:

- Common Architecture and Technology
- Enabling Public Sector Benefits
- Enabling Industry Growth
- Developing Network of EO Platforms
- Evolving Technical Capabilities

 Significant opportunities for data providers, information service providers, cloud and ICT developers and service providers, science, applications, research institutes, platform developers, platform service providers, EO digital marketplace brokers, users, value adders, SMEs ...

TEPs on track starting to see tangible results

Pre-ops starting (some now, some end-year)

TEPs provide necessary R&D, capabilities, and experience to address the expanded objectives of EOEP-5, in particular EO Innovation Europe and the Network of Platforms

Thanks !