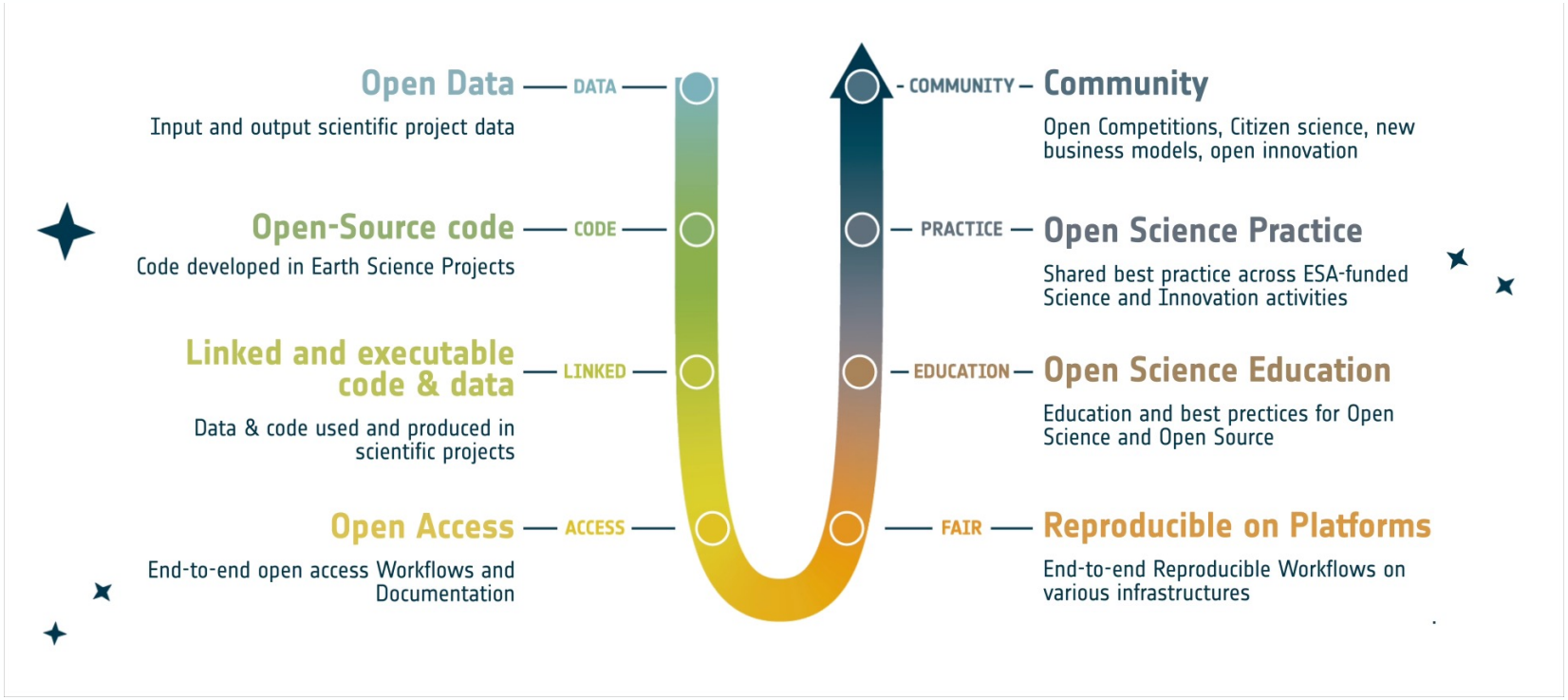
Splinter #4 Open Science & Digital Innovation

Splinter 4 – Building 15

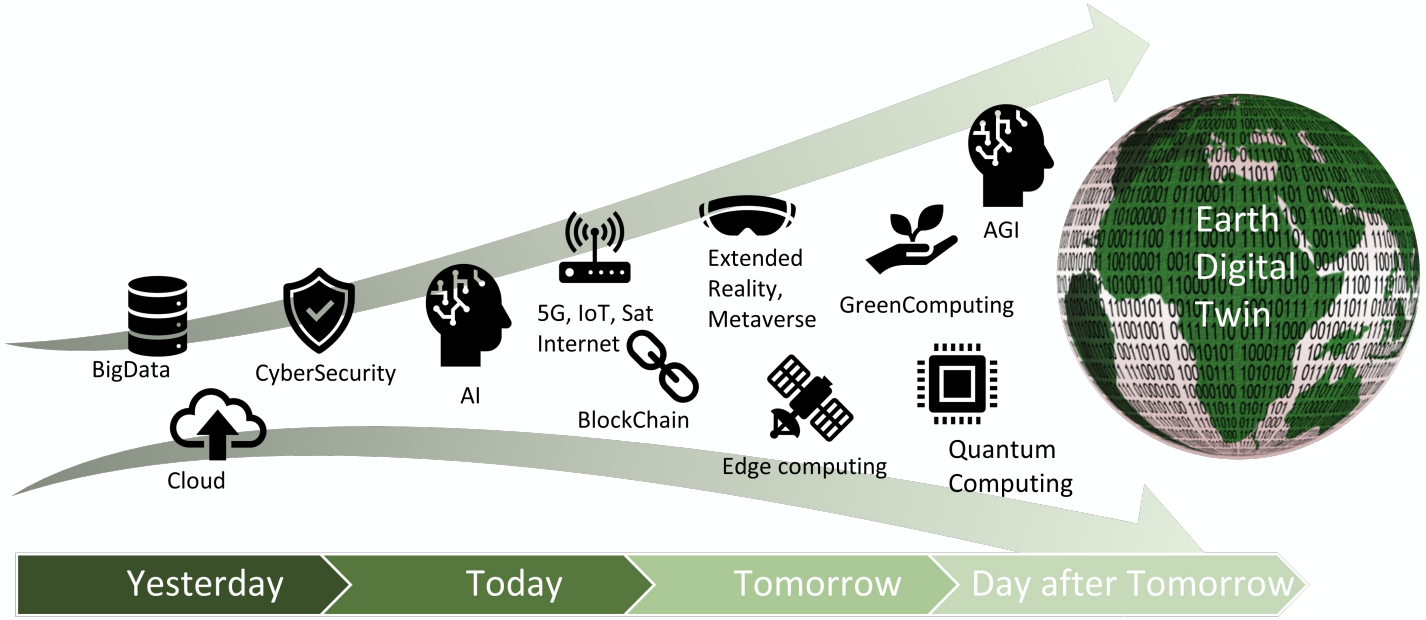
ESA EO Science Strategy Workshop 2024
ESRIN 07. – 08.05.2024

Culture of Openness



Recommendations:
- Include "Provenance and Sustainability" in this figure.
- Include explicitly in the strategy document text the terms "reproducibility, provenance and sustainability".

Digital Innovation - Trends and Opportunities



with inspiration from Cap Gemini roadmap

- Maximise data exploitation and the socio-economic benefits of AI integration within European data pipeline
- Revolutionise Resources and Hazards management with AI action-based applications
- Lower the adoption barrier for EO driven solutions with operational value-adding on-demand cloud services
- Empower end-users EO data exploitation by providing transparency and trust (DLT, web3, and explainable AI)

Draft Science Strategy Strategic Objectives - recommendations

To foster the development of a culture & practice of openness in EO science, applications and industry, and of a sustainable open innovation ecosystem.

To develop and enhance European capabilities for harnessing digital innovation, ~~particularly~~ such as AI, to maximise the exploitation of EO data for scientific and socio-economic benefits.

NEW: To facilitate cross-disciplinarity, cooperation and engagement of complementary expertise (EO and non-EO) into scientific and innovation processes.

Other Recommendations:

- Associate KPIs to the objectives (applicable for all objectives) or define ways to measure achievements, e.g., by defining high-level results
- Try to make objectives more SMART

Splinter Seed questions

Q1. How can Open Science (OS) and Digital Innovation (DI) Accelerate Scientific Discovery?

Q2. How can we turn Scientific results into services for society through OS & DI?

Q3. How can OS & DI best help to reduce critical knowledge gaps in the short term with current or near future resources?

Q4. How can OS & DI can be used to fill critical observational gaps looking to the long-term?

Q5. Where and how is digital innovation expected to make the biggest impact in pursuing the EO science priorities?

Comments to strategy text:

- To foster adoption of FAIR Open Science principles by the community, institutional support is key but not enough. There is a need to incentivise industry to participate in the Open Innovation process, to make open science & innovation sustainable

Addressing the seed questions

The following aspects were considered in the Splinter discussion when addressing the 5 seed questions.

A. Practice:
   1. What elements of Open Science Practice are relevant for this question?
   2. What are the limitations?

B. Technology
   1. What are the technologies with the highest impact potential?
   2. What are the limitations?

C. Science text:
   1. Is the strategy capturing well all elements?
   2. What should be added?
   3. What should be removed?

Q1. How can Open Science and Digital Innovation Accelerate Scientific Discovery?

The following Open Science practice elements are fundamental to Accelerate Scientific Discovery:

- **Reproducible and FAIR scientific data and workflows** – to allow reuse, evolution, reduce duplication of efforts and cost
- **Cross-disciplinary collaboration** – including with non-EO domains, and between science and technology
- **Transparency & Trust** – to allow for more participation and validation of science

The following elements should be reinforced by Digital Innovation and investments in technology:

- **Certifiable Data Sources**
- **Technologies for Traceability & Provenance** of Data and Workflows across all ESA data & products (through centralised and decentralised solutions), to enhance, traceability, protection, trust and useability of data more reusable, but comes with financial and energy cost
- **Technology enabled reproducibility** (interoperability, standards, workflow management, etc).

Other recommendations:

- Maintain reproducibility and provenance linked throughout the text.
- Update text to include support to developing countries
- Expand Objective 3 in the text

Q2. How can we turn Scientific results into services for society through OS & DI?

Practice:

- **Culture of openness** facilitates transfer through reproducibility and by best practices adopted by the community (i.e. scientists providing outcomes already useable or transferrable to applications)
- **Communication & Capacity building** on the best practices for Open Science, so that reproducibility becomes a fundamental part of the scientific process and is not regarded as extra work
- **Partnerships between science and industry**/institutions, creating a path from discovery to benefit for society
    - From "scientifically excellent" to "good enough for a service"
    - Long-term sustainability of workflows (Maintenance, responsibility for algorithms, funding, resources)
    - Incentives for scientists: e.g., Recognition and credit for "most open & reproducible research" or for research with "Most societal benefit"
    - Incentives for companies to join an open innovation approach (e.g., certifications, best practices, know-how transfer)
    - Education, Hackathons, Networking events, opening commercialisation events to scientists

Digital Innovation & Enabling technologies

- Following the model of the Network for resources, to develop **network of code, network of workflows**
- Technology to facilitate bridging between science and applications/services, e.g. a **match-making platform for science & innovation**

These 3 questions on Short and Long-term Impact were addressed together in the splinter

Q3. How can OS & DI best help to reduce critical knowledge gaps in the short term with current or near future resources?

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Q5. Where and how is digital innovation expected to make the biggest impact in pursuing the EO science priorities?

Short & long term impact

Open Science Practice:

- Adoption of FAIR and Reproducibility in the scientific process are fundamental prerequisites for maximum impact
- Foster societal benefits and helping institutional stakeholders in technology best-practice implementation
- Foster uptake of Open Science to ensure sustainability and long-term availability and useability of science results
- Promote international collaboration with other (non-ESA) data providers to address CSQs that cannot be answered with ESA data only
- Provide standardised uncertainties with the data,
- Promote and enable sharing of validation protocols, and enable independent validation
- Increase attractiveness of European offering by transparency, trust, reproducibility, accessibility, long-term open vision

Digital Innovation & Technology

- Inter-agency data access, collaboration on interoperability and standards, Federated catalogues, standardisation across missions.
- Accessible tools for QA/QC generally applicable for ESA products
- User-centric designs of EO-enabled information products and services
- Ensure Long-term accessibility of the platforms and science results repositories to enhance trust and grow adoption
- Leveraging European HPC and EOSC requires workflows transparency and reproducibility
- Link high computing power with the data & lower the access barriers to the use of HPC
- Develop and evolve on-demand deployable environments for science and applications

Key concepts to be added/enhanced in the Science Strategy document text

- Reproducibility
- Sustainability
- Provenance
- Cross-disciplinary cooperation (EO <> non-EO)
- DATA (ACCESS)

Summary text

The adoption of FAIR (Findable, Accessible, Interoperable, and Reusable) and Reproducible principles stands as the cornerstone of modern scientific progress. Incorporating these principles as fundamental elements of the scientific practice has profound impacts on the acceleration of discovery.

Together with accelerating the pace of innovation, reproducible science practice catalyzes a fundamental shift towards an open-innovation economy, paving the way for a seamless transition of scientific breakthroughs into tangible services that benefit society at large.

Moreover, the realm of opportunity extends far beyond traditional Earth Observation (EO) domains. Non-EO sectors, such as data science and other mature digital technologies, offer vast untapped potential. Collaboration with non-EO actors across different impact sectors and integrating their non-EO data assets (such in-situ data, socio-economic and other contextual data) is also essential to deliver customized solutions that address the needs of end-users. Collaboration with these communities is key to drive unprecedented benefits derived from our scientific endeavors. This motivates the inclusion of a 3rd Objective in the strategy.

For our long-term vision, sustainability and accessibility are paramount. We must ensure that the scientific results and technologies we develop today remain accessible tomorrow. This not only fosters trust within the scientific community but also lays the groundwork for continuous innovation and service delivery.

Collaboration amongst scientists and between scientists and industry/institutions is what ultimately drives the "health" of this ecosystem. ESA can play a pivotal role by driving technology innovation, facilitating networking and "match-making" and by supporting capacity building and EO data uptake in developing countries.

Transparency and trust are tightly coupled. Investment in supporting technologies for integrity, traceability and provenance of data and workflows and promoting exchange of data and knowledge on validation protocols are indispensable.

Data access remains a key area to enable reproducible science. Alignment and harmonization with international partners on standards and interoperability is essential to unlock new frontiers of discovery and innovation.