

# SPACE DATA SPACE

## Expectations towards a Gaia X roadmap for the European Space ecosystem

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This position paper is based on a collaboration initiated in November 2020 through the Digital Alliance for “Space” within GAIA-X, where four European companies announced a new cross-border alliance to accelerate the development of “Space” data value creation: 3DS OUTSCALE, CS GROUP, EBRC and RHEA Group joined their forces to **develop new Trusted Services for the fast growing and sensitive “Space” data & applications industry**, following and thereby stimulating the European GAIA-X initiative. The intention of this document is to share widely our ecosystem’s expectations and to provide a first overview / indication as to a desired 2021-2025 roadmap.

We, space agencies and research laboratories, satellite manufacturers and operators, ground stations providers and operators, space equipment manufacturers, ground segment integrators, ground or on-board software developers, cloud service providers of the European Space community, expect strong business benefits and joint tangible outcomes from the creation of the Gaia-X ecosystem, which will further stimulate the European demand and usecases for space-data-driven applications, and we actively support the emergence of federated service & data platforms that create value for all our businesses– and ultimately to European citizens.

The space industry has experienced a major growth over the last two decades, with the launch of major European and institutional satellite programmes for navigation, communication and Earth observation, as well as through strong traditional and disruptive ‘New Space’ commercial initiatives. As a result, the amount of space-generated data has surged. Today, our everyday lives rely heavily on such data within many consumer and professional applications and use cases. Our dependency on space data and the information it provides demands that such data is handled securely, robustly, accurately and efficiently, and that its European sovereignty is assured. This is the mission that the four core partners want to stimulate through the **creation of this GAIA-X Space Data Space, and welcoming every other actors of the space value chain.**

Space Data Space is fully in line with GAIA-X objectives in the sense that **it fosters new services and new data sets** and these new assets can serve other sectors/data spaces of GAIA-X. These services mainly concern the space ground segment (upstream) and the use of space data (downstream) that is exploding.

Space ground segment evolution already benefits from cloud infrastructure. Thanks to GAIA-X federation and its potential worldwide distribution, it can scale to a full service bypassing the need for hardware and software ownership. Cloud infrastructure connected directly to ground stations networks will provide **“ground segment as a service”** capabilities for:

- Mission operations integrating new cloud native and turnkey Mission Control and Flight Dynamics Systems, with the capacity to be scalable from single nanosatellite to super constellations.
- Payload data processing aggregating ground stations data streams and integrating on the fly data processing chains, thus optimizing network bandwidth and storage.

“Ground segment as a service” opens up the market to new space actors including start-ups and then **generates even more data coming from space**. Several initiatives for Space data access already exist on the cloud. The European major one is the COPERNICUS DIAS (Data Information and Access Service) that are using 5 independent cloud infrastructures. The interoperability layer of GAIA-X will allow a better interconnection and synergies between these initiatives allowing the **creation of a federated space data catalogue**, ready to welcome also data from new Earth Observation missions as operated through the GAIA-X Ground Segment as a Service, as well as to be combined with other ground-originated data.

The federated space data catalogue will embed AI services for the extraction of actionable insights from these large amounts of space data, for automation of repetitive processes, and then extending the use of space-based applications to new markets. Linked to this catalogue and associated services (upstream for data generation and downstream for data exploitation), the processing power of GAIA-X will benefit from technologies, such as block chains, for end-to-end data certification service (from the space sensor till end-users), making available a **certified and federated space data catalogue**, ready to be used by others GAIA-X data sectors.

The space data sector promotes services to respond to European stakes:

- To keep the business of ground segment development and mission operation in Europe, thanks to a federation of European cloud,
- To use the processing power of European Cloud and then generating new business for European industry,
- To keep European space data in Europe and foster the creation of new European business services leveraging this data,
- To generate and reference European space data to ease their integration in other markets with other data sources,
- To ensure European digital trust as an enabler for adoption of digital services using space data,
- To boost the business of European ground station providers,
- To accelerate time to market and ensure competitiveness of future European new space missions.

- **We have outlined below three maturity-based stages** that shall drive future result-oriented cooperation within the Space data space, and shall drive future funding from the European Commission's dedicated funds and/or ESA funds. The next two sections are detailing 2 major, priority, quick wins.

#### 2021-2022: "quick wins"

- A common space data framework set up by Gaia X governance, in connexion with European and national regulators and governments, and leveraging existing initiatives such as Copernicus DIAS.
- Secured innovation and experimentation platforms to support co-innovation with multi-entity participation. Exploring future AI and data-driven use cases, for the space industry as well as for cross industry use cases.
- Standard analysis and definition for ground segment as a service in connection with existing CCSDS and ECSS standards.
- Promotion kit to enlarge usage of space data to other sectors including hybrid utilisation of non-space data.
- Space services and data mock-up serving education of young graduate and SME.

#### 2022-2023: mid-term benefits building on already-launched or soon-to-be-launched projects

- Cloud based Payload processing chain Proof of concept based on GAIA-X federation.
- Federated space data catalogue based on open source data, ready to be used.
- Block chain or other technologies exploration for end to end certification.
- Specific university programs for space services and data.

#### 2023-2025: long term benefits requiring significant investments on the 2021-2025 period

- Pay per use Ground segment as a Service for mission operation and payload data processing.
- Pay per use certified and federated space data catalogue.
- End to end certification and security testing of virtual space systems.

# GAIA-X - Space Data Space - Quick Win #1: Common space data framework for DIAS federation

## 1 Problem statement

### 1.1 Current situation

Today, in Europe there are five operational Copernicus DIAS (Data Information Access Services) that have been funded by the European Commission and implemented by ESA (four, through different commercial industrial operators: Mundi, Sobloo, ONDA Creodias) and, jointly, by ECMWF, EUMETSAT and Mercator Ocean WekEO). The different Copernicus DIAS have been implemented on common baseline requirements (e.g. Data Offer including to Copernicus Sentinels archives), however each single DIAS has different choices with respect to the selection of the public cloud infrastructures to host data and services, platform interfaces and services, data rolling archive policies, etc.

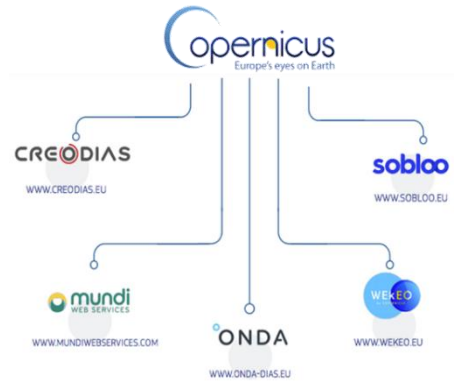


Figure 1. Copernicus DIAS

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### 1.2 Top Challenges

In the initial vision of the Copernicus DIAS, these infrastructures are the enablers of innovative data exploitation services thanks to the co-location of large satellite and non satellite data archives with scalable and elastic processing capabilities offered by European commercial cloud providers. This in contrast with the offering of large US digital corporations such as Amazon and Google that are offering similar services (full EO data archives co-located with their own data processing facilities).

However, the operational exploitation of currently available Copernicus DIAS capabilities in mission critical applications is still limited by several factors that are posing concrete challenges such as:

- **Heterogeneity of the Data Offer and of the data retention policies applied** (spatial/temporal), which may result in extremely long waiting time to retrieve older data that are not compatible with business applications needs
- **Heterogeneity of the DIAS Platform interfaces**, which creates an additional burden on the side of the downstream application developers in the development of ad hoc connectors and interfaces to interact with the platform services offered by the different DIAS, creating *de facto* a vendor lock in
- **Large EO data archives duplication**, resulting in significant cost inefficiencies and, ultimately, in higher prices for the end customers once the public funding of the initial DIAS operations will be over.
- **Security**, since the level of security offered by the DIAS is essentially based on the standards available from the public commercial cloud providers engaged with no specific certifications to manage, for example, services towards national public institutions
- **Reliability**, since the current Service Levels offered by commercial cloud providers may not be adequate to support the implementation of critical services as the large incident recently suffered by OVH Data Center in Strasbourg has widely demonstrated

## 2 Objectives

The objective of the Quick Win #1 “Common space data framework for DIAS federation” is to **implement a Proof-of-Concept (PoC) to demonstrate the technical and operational feasibility to implement a federation of the different Copernicus DIAS services to offer a superior service to highly demanding, mission critical business applications.**

The PoC will leverage assets and concepts currently available to European space industry, leveraging recent developments in the definition of best practices in the design and development of federated data and service catalogues, hybrid cloud orchestrators, security by design and DevSecOps concepts.

## 3 Activities

The high level activity plan related to the implementation of Quick Win #1 is briefly summarized below:

- **Task 1 Mapping:** mapping the current Copernicus DIAS Offering, data retention policies, reliability of the infrastructure with full data recovery, platform access interfaces (API), IaaS offering, PaaS/SaaS offering as well currently available solutions to build federated data and service catalogue and hybrid cloud platforms. In addition, mapping of security ICT in place on the various DIAS, mapping of performance of the various functionality aiming to detailed the gap analysis.
- **Task 2 Understanding:** identify which are the most relevant information and requirements for Champion Users (e.g. downstream industry) to drive the high level design of the PoC functionalities and interfaces and build the backlog of User Stories;
- **Task 3 Design:** sketch the architecture of the technical solution, start collecting the available building blocks and define the necessary glue to build the final PoC;
- **Task 4 Implementation:** build the PoC in a couple of Sprints, with an intermediate check with the identified Champion User(s) to validate the implemented PoC concept and ,if necessary, slightly adjust it;
- **Task 5 Validation & Recommendation:** perform a quick validation and return on experience with the engaged Champion User and prepare a short set of lessons learned ad recommendation for a future implementation of federated Data and Service catalogue in the Gaia-X framework

## 4 Expected Impact

The expected impact of the Quick Win #1 is to achieve a first example of federation of data and services among different DIAS to enable End Users to:

- Easily discover available data and services in different DIAS endpoints through a unified search interface;
- Easily build generic processing pipelines in different DIAS platforms through a unified processing engine and a flexible hybrid and multi cloud orchestrator;
- Trust the security offered by the Gaia-X federated platform to host mission critical data and applications.
- Removing the concept of data location through the provision of a transparent access

In addition, the Quick Win #1 will also generate a detailed report to guide the design and implementation of Gaia-X specifications to support the implementation of scalable, secure and trusted downstream digital services powered by Gaia-X infrastructure.

# GAIA-X - Space Data Space - Quick Win #2: Ground Segment as a Service (GSaaS)

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## **The issue: Hyperscaler actors such as AWS and AZURE are taking position on GSaaS**

The New Space (or post New Space) trend is changing the needs of satellite operators who have to face to: smaller satellites, shorter development and operational life time and the multiplication of constellations. In the meantime, Space customers are increasing with more complex demand where flexibility of the missions, performance and interoperability between the missions are essential.

In this context, the ground segment is a key differentiator in this space systems market. In order to respond to these revolutions, it requires greater flexibility and then has to operate a profound overhaul, borrowing concepts and methods of IaaS and cloud computing: the Ground Segment as a Service (GSaaS).

The geographical distribution of the ground segment, particularly through its ground stations (antennas) is key for the GSaaS to provide the maximum performance of the communication with the satellite, sending telecommands and downlinking telemetries, as well as managing the system resources in an efficient, scalable and flexible way . Hyperscaler actors such as AWS and AZURE provide an optimum solution thanks their numerous data centers connected to antennas.

GAIA-X with its objective of a Sovereign federation of European Cloud providers could compete with these GAFAM initiatives.

## **The opportunity: GAIA-X federates European capabilities**

The objective of this GSaaS quick win is then to pave the way of the future European operators of this next generation of ground segment by preparing GAIA-X federation of IaaS providers so that it can meet the high demanding constraints of GSaaS.

The main ideal output of the GSaaS quick win would be the study of how these GSaaS constraints could be resolved by GAIA-X federation and then design the associated federated IaaS infrastructure based on European Cloud. A prototype could then be implemented.

## **The proposition: a full study and prototyping**

The following activities are then foreseen:

1. **Synthesis** of GSaaS high level requirements that have impact on the IaaS infrastructure.
2. **Analysis** of these requirements and identification of the main constraints on the IaaS (geographical distribution, link with ground stations, data transfer and processing performance, security, ...)
3. **Architecture** of the IaaS infrastructure, interconnections and foundation/processing services (based on several cloud providers and linked to ground stations networks).
4. **Prototyping** of this IaaS federation solution and test, leveraging on GSaaS components (provided by Space Data Space members).
5. **Recommendations** on the GAIA-X federation to ease GSaaS implementation.