## **Copernicus Space Component**

**Technical Operating Arrangement** 

European Space Agency – National Authority for Government Innovation of Panama



# **Copernicus Space Component Technical Operating Arrangement**

between the European Space Agency on one side,

and

the National Authority for Government Innovation of Panama on the other side,

executing the Cooperation Arrangement concluded between the European Commission and the National Authority for Government Innovation of Panama on their cooperation in the area of data access and use of Copernicus Sentinel data of the Union Space Programme.



### 1 INTRODUCTION

### 1.1 Background

Copernicus is a European programme, providing Earth Observation information for environmental monitoring and civil security. The dedicated Copernicus Sentinel missions are being developed to meet the operational needs of the programme.

Copernicus now forms part of the European Union's Space Programme, which was established under Regulation (EU) 2021/696 of the European Parliament and of the Council of 28 April 2021 establishing the Union Space Programme and the European Union Agency for the Space Programme ('the EU Space Programme Regulation'). Within the frame of the European Union Space Programme Regulation, the European Commission has concluded agreements with the European Space Agency ('ESA') and the European Organization for the Exploitation of Meteorological Satellites ('EUMETSAT') for continuing the implementation of the space component of Copernicus.

These agreements foresee that ESA and EUMETSAT will provide support to the European Union ('EU') for matters concerning the international technical cooperation of Copernicus. In particular, ESA and EUMETSAT will assess the impact of international technical cooperation requests and will implement and be responsible for technical actions with international partners subject to the prior approval of the European Commission and prerequisite funding provided by the European Union.

On this basis, the European Commission requests ESA and EUMETSAT to establish relevant technical operating arrangements with international partners, primarily focusing on the Copernicus Sentinels operated by ESA and EUMETSAT and addressing issues such as liability and technical data interface specifications.

ESA and EUMETSAT will be responsible for the implementation of the technical actions, in coordination and subject to prior consultation with the European Commission.

The implementation of the technical operating arrangements will be facilitated by a joint 'Copernicus Cooperation group', involving the European Commission, ESA, EUMETSAT, the European Environment Agency ('EEA') and the international partners. The members of the Copernicus Coordination group will meet whenever necessary, to oversee and stimulate cooperative activities as mentioned in the relevant Cooperation Arrangement.

### 1.2 Purpose and objectives

The EU, represented by the European Commission, and the National Authority for Government Innovation of Panama ('AIG') signed a Cooperation Arrangement on 12

December 2022 on Cooperation in the area of data access and use of Sentinel data of Copernicus of the Union Space Programme ('the Cooperation Arrangement'). The Cooperation Arrangement reflects both sides' recognition of the current and potential value of Earth Observation ('EO') data, and identifies areas where AIG and the European Commission see potential for cooperation to help realise this value.

In the Cooperation Arrangement, both signatories recognise that the European Union and Panama are pursuing EO activities in a number of areas of common interest and that sharing each other's data based on reciprocity should provide mutual benefits. Both sides acknowledge that access to in-situ data provided by AIG will benefit the Copernicus Programme.

Both sides are committed to the principle of full, free and open access to Copernicus Sentinel and other European EO data and information, subject to applicable security restrictions.

The European Commission wishes to provide Panamanian organisations access to Copernicus Sentinel data using high bandwidth connections from data hub to data hub, with a view to fostering the exchange of EO data between Europe and Panama.

Furthermore, the European Commission would like to emphasise the importance for the Copernicus programme of in-situ data from Panama.

Acknowledging that the Copernicus programme emphasises the importance of in-situ observations and the complementarity with space-based observations, AIG wishes to support this objective and intends to facilitate access to data from local monitoring stations throughout Panama, including geophysical and meteorological networks, to support the enhancement of the Copernicus data architecture and the development of global products.

This Technical Operating Arrangement ('TOA') is established in order to give technical effect to relevant aspects of the Cooperation Arrangement. ESA and AIG will collaborate to undertake the necessary technical activities. These activities are described in the present TOA.

The TOA defines the respective roles and responsibilities of ESA and AIG, as well as the terms and conditions under which they will cooperate to implement the exchange of data foreseen in the Cooperation Arrangement in the area of data access and use of Copernicus Sentinel data.

The TOA will be implemented based on voluntary, non-legally-binding cooperation, without exchange of funds. In the event that either ESA or AIG is unable to continue one or several of the activities described in this TOA, each signatory may discontinue participation in such activities. In such cases, the signatories will endeavour to consult each other and provide each other with reasonable notice of their intentions.

The signatories agree that any future evolution of the technologies in the infrastructure and operational domain which has the potential to become relevant for the implementation of the present TOA but which goes beyond the current capabilities of the signatories will be duly considered by them, without creating an obligation for the signatories to adopt/ acquire these new technologies. The signatories will consult each other should this case materialise, endeavouring to ensure continuity of the TOA's implementation.

The TOA will take effect on the date on which the second of the two signatories signs the TOA.

### 1.3 Scope

This TOA, which does not create any rights or obligations, describes the technical operating arrangements between AIG and ESA which are necessary to give effect to relevant aspects of the Cooperation Arrangement. The technical operating arrangements include a description of the initiatives over which the signatories will cooperate, the necessary operational interfaces, and the support required from each signatory.

#### 1.3.1 The main activities intended to be carried out by AIG are:

- a. The development of a data centre providing regional access to Copernicus Sentinel data (as part of the Regional Copernicus Centre in Panama ('CopLAC')), covering the geographical area of interest that includes the land and marine territories of the countries identified in Annex A, as described in detail at Section 4.1 below.
- b. Facilitating the uptake of Copernicus Sentinel data from the data centre by AIG's partner institutions in Panama, and in Latin America and the Caribbean.
- c. Providing the in-situ data described at Section 3 below for the benefit of the Copernicus component of the European Union Space Programme. AIG will, where possible, facilitate access for Copernicus to in-situ data available from regional (Latin America and the Caribbean) data sources in addition to national data sources.

### 1.3.2 The main activities intended to be carried out by ESA are:

a. ESA will provide to AIG the access reserved for the EU's Copernicus international partners to the Copernicus Data Space Ecosystem, which is managed by ESA, or to any equivalent privileged data access service for Copernicus Sentinel data operated on behalf of ESA for the EU's Copernicus international partners which is put in operation to replace the access to the Copernicus Data Ecosystem after the date of signature of this TOA. The logistics of this data access are described in more detail at Section 4.2 below.

- b. ESA will provide the related technical support required to ensure the correct functioning of this access to Copernicus Sentinel data.
- 1.3.3 Additional areas of technical cooperation may be included in the future, if relevant and endorsed in advance by the European Commission.
- 1.3.4 The Annexes to this TOA form an integral part of the TOA, but they can be revised and updated through explicit joint agreement in writing and such a revision or update shall not require a formal signed amendment of the TOA.

#### 1.4 References

An overview of the Copernicus Sentinel missions is available on the Sentinel Online portal at <u>sentinels.copernicus.eu</u>. In particular, the portal contains up to date information on:

- Each of the Copernicus Sentinel missions which is operated by ESA, describing both the space and ground segment aspects, and providing news from the operations;
- · Available products, including the contents and format specifications;
- · Detailed user handbooks; and
- How to link to the data access hubs, including registration process, user manuals, and operational news.

The Copernicus Data Space Ecosystem is an open ecosystem which is operated on behalf of ESA to provide free instant access to a wide range of data and services from the Copernicus Sentinel missions and more on our planet's land, oceans and atmosphere. The Copernicus Data Space Ecosystem is a core part of the Copernicus Space Component which is managed by ESA as part of its entrusted tasks within the European Union Space Programme. The Copernicus Data Space Ecosystem is publicly accessible online at the internet address: <a href="https://dataspace.copernicus.eu/">https://dataspace.copernicus.eu/</a>.

The following documents are referenced in this TOA and provide further supporting information for the cooperation:

- CSC Operations ESA Framework Operations Concept, [latest version at the date of signature: issue 1.1, ESA- EOPG-EOPGC-TN-19, dated 27 September 2022]. A copy of this document is appended to this TOA at Annex C.
- The European Commission's legal notice setting out the conditions of the licence under which Copernicus Sentinel data and information may be used: "Legal notice on the use of Copernicus Sentinel Data and Service Information", accessible online via

https://sentinels.copernicus.eu/documents/247904/690755/Sentinel Data Legal Notice

A copy of this document is appended to this TOA at Annex D.

#### 2 TECHNICAL INTERFACES

AIG will act as the technical interface to ESA for carrying out the activities described in this TOA.

Where other entities (e.g. institutes, ministries, commercial enterprises, etc.) are involved in the implementation of the TOA on behalf of AIG, AIG will act as the sole interface to ESA and the contact point for any such entities.

Where ESA identifies a desire to access data to support calibration and validation, or wishes to discuss complementary calibration/validation activities, AIG will act as a coordinating point to facilitate such discussions.

Where the European Commission and/or the European Environment Agency ('EEA', the delegated entity for the cross-cutting coordination of the Copernicus in-situ component) identify a desire to access in-situ data from Panama to support the Copernicus Services, AIG will act as a coordinating point to facilitate such discussions. The detailed arrangements covering this specific cooperation are outside the scope of this TOA.

Occasional technical meetings are intended to be held between AIG and ESA, for instance within the Copernicus Cooperation Group which will be led by the European Commission. The European Commission will be invited to all meetings between AIG and ESA, and all meeting documentation will be forwarded to the European Commission for information.

# 3 EUROPEAN ACCESS TO CALIBRATION AND IN SITU DATA FROM PANAMA, LATIN AMERICA AND THE CARIBBEAN

AIG will, where possible, facilitate access for Copernicus to Panamanian, Latin American and Caribbean networks of climatological, meteorological and other in-situ and EO data that can support the calibration and validation of satellite Earth observations and images derived from those Earth observations, as well as provide input to the Copernicus Services.

Data from these networks, and other data and information of value to calibration/validation activities and the Copernicus Services will be made available to the Copernicus programme in accordance with national, state/territory and organisation-level policies.

It is understood that the data made available by AIG and/or its partners in the course of the implementation of this TOA will be made available for onwards use on the Copernicus Data Space Ecosystem, or equivalent publicly accessible Copernicus data access service. Consequently, the transmission of these data will allow for such a distribution, without

restriction. ESA will serve as facilitator for data transmission to the Copernicus Data Space Ecosystem, or equivalent Copernicus data access service.

# 4 INTERNATIONAL ARCHIVING AND DISSEMINATION CENTRES – DATA MIRROR SITE

#### 4.1 Data Mirror Site

AlG intends to establish a regional Copernicus data access/analysis mirror site ("Data Mirror Site"), to improve access to, and the exploitation of Copernicus Sentinel data in Panama, Latin America and the Caribbean.

In the context of the present TOA, this Data Mirror Site is intended to retrieve data from ESA-operated Copernicus Sentinel missions from ESA-operated data systems, and then to store and make available such data to government, industry, research and general public users for download and/or online analysis. The Data Mirror Site is intended to access all data products produced by all ESA-operated Copernicus Sentinel missions for a geographical area of interest that includes the land and marine territories of countries identified in the map in Annex A.

The specific data products to be retrieved, and the scope of the geographic region for which data will be retrieved/stored/re-distributed, may change from time to time. AIG will discuss such changes with ESA prior to implementing them in the Data Mirror Site. For the purpose of technical efficiency, simpler geographical boundaries may be employed that encompass an area larger than the specific area of interest.

The Data Mirror Site is intended to be a distributed system, designed according to the characteristics agreed by the parties and based on ESA's previous experience.

AIG intends to utilise high bandwidth networks capable of peering to GEANT on the European side (e.g. academic research networks or other), as the backhaul connection from ESA-operated systems to the Data Mirror Site. Such networks are scaled for data of the size of Copernicus Sentinel data products, and are a cost-effective way of moving large amounts of scientific data. AIG understands that ESA intends to directly connect ESA-operated data systems with the European GEANT network using high-bandwidth connections.

The types and levels of service provided by the Data Mirror Site (such as web service access, direct file download, etc.) will be determined from time to time by AIG in consultation with its partners and ESA.

Access to data will always be provided in a manner consistent with the overarching terms documented in the Cooperation Arrangement.

AIG will implement a simple and un-bureaucratic user registration process for the Data Mirror Site, in order to support the onwards distribution of Copernicus Sentinel data in the region and to share aggregated information with ESA and the European Commission. As part of the user registration process, users will be asked to state, by choosing from a drop-down menu, the country in which they operate, the category of user into which they fall, and their intended field of use for the data, to enable AIG to provide ESA with the annual statistics described at Section 4.4 below.

### 4.2 ESA Support

### 4.2.1 Access to the Copernicus Data Space Ecosystem

ESA shall provide AIG with an account reserved for ESA's international Copernicus partners on the Copernicus Data Space Ecosystem, which is operated on behalf of ESA. The Copernicus Data Space Ecosystem provides bulk dissemination capabilities for Copernicus Sentinel data products, as well as a range of hosted local processing services.

AIG or a delegated partner will directly connect to the Copernicus Data Space Ecosystem, or equivalent Copernicus Sentinel data access point. Other partners may be engaged as required, following prior consultation with ESA and the European Commission.

The Copernicus Data Space Ecosystem will continuously store Copernicus Sentinel data acquired during the previous month(s) at the processing levels agreed as part of the Copernicus Sentinel data portfolio and the associated timeliness as defined in the document 'CSC Operations - ESA Framework - Operations Concept', (latest version: Issue 1.1, ESA-EOPG-EOPGC-TN-19, dated 27 September 2022), a copy of which is appended to this TOA at Annex C. The Copernicus Data Space Ecosystem enables searching, browsing, previewing and downloading all Copernicus Sentinel data, as well as range of hosted local processing services.

Access to the Copernicus Data Space Ecosystem is allowed via a web authentication module. ESA will provide AIG with a username and password to access the Copernicus Data Space Ecosystem. This username and password may be used only by AIG (including its representatives, employees and contractors involved in the initiative) for the purpose of the initiative and will not be shared with other natural or legal persons.

AIG will use the Copernicus Data Space Ecosystem access, or equivalent Copernicus Sentinel data access service only for the purpose of its activity in the Data Mirror Site initiative described above. Through registration at the Copernicus Data Space Ecosystem, or to the equivalent Copernicus Sentinel data access service, accessing and\or downloading available content, AIG will not misuse or interfere with the service of the Copernicus Data Space Ecosystem portal or that of the equivalent Copernicus Sentinel data access service. In particular, AIG aims at building a mirror archive of Copernicus Sentinel data over its area of

interest and hence will not repeat the download of identical datasets from the Copernicus Data Space Ecosystem, or from the equivalent Copernicus Sentinel data access service, but will store downloaded Copernicus Sentinel data for re-use and re-dissemination.

All functionalities and contents offered by the Copernicus Data Space Ecosystem, or by the equivalent Copernicus Sentinel data access service, are provided by ESA on a best efforts-basis. The transmission of content from the Copernicus Data Space Ecosystem, or from the equivalent Copernicus Sentinel data access service, may be interrupted or delayed by ESA in the event of technical constraints, such as the internet bandwidth. In such case, the download requested by AIG will be enabled later taking into account other users' requests.

#### 4.2.2 Data Transfer

ESA will provide appropriate interfaces to transfer Copernicus Sentinel data to AIG and its partners. If required, ESA can support network performance analysis to help fully utilise available bandwidth.

#### 4.3 Time Schedule

ESA will provide Copernicus Sentinel data as they become available in accordance with ESA's data provision plan (e.g. after launch, commensurate with the commissioning and ramp-up plan for data provision).

#### 4.4 Reporting

AIG will keep ESA and the European Commission informed about the course and success of the Data Mirror Site.

AIG will submit regular reports regarding the Data Mirror Site on at least an annual basis. The annual reports will, as a minimum, contain information regarding:

- The use which AIG has made of Copernicus Sentinel data during the year, and any applications it has developed;
- Onward use or dissemination of Copernicus Sentinel data, including in particular statistics regarding user activity on the Data Mirror Site;
- Any changes to the pre-agreed set up of activities that may have an impact on ESA's support to the partner's activities;
- AIG will provide feedback to ESA on the Copernicus data access mechanism.

More specifically, as concerns Data Mirror Site usage statistics, AIG will provide an annual set of statistics covering as a minimum:

a) Statistics on the Copernicus Sentinel data offer on the Data Mirror Site:

- Volume of Sentinel data acquired for the Data Mirror Site from a data access interface operated on behalf of ESA;
- Number and volume of Sentinel user-level data products published on the Data Mirror Site, by mission and user-level data type.
- b) Statistics on the level of user-uptake from the Data Mirror Site:
  - Number of registered users on the Data Mirror Site, number of new users, and number of active users during the reporting period, including users' geographic origin, affiliation, thematic activity, and sector of activity;
  - Number and volume of Sentinel user-level data products downloaded by the users via the Data Mirror Site, by mission, by product type, including users' geographic origin, affiliation, thematic activity, and sector of activity;
  - Complementary Sentinel data and information developed by AIG or its partners;
  - Support provided to Copernicus calibration and validation activities by AIG or its partners.

The template for providing this information to ESA is attached at Annex E below.

The collection of these statistics will require AIG to structure the user registration process so that when users register, they provide the following information to be associated anonymously with their user account:

### a) User geographic origin

Users will be asked during the registration process to state the country from which they will primarily download the data.

#### b) User's organisation

Users will be asked during the registration process to state the type of organisation for which they work, using the following list of categories:

- International public organisation;
- National/regional/local public authority;
- Research and education organisation;
- Business/commercial/professional Small and medium-sized enterprise ('SME');
- Business/commercial/professional non-SME;
- Charity or NGO;
- Private individual personal interest;
- Other.

### c) User thematic activity

Users will be asked to select their main intended area of application for the data from the following list of application areas:

- Land;
- Marine environment, maritime affairs and fisheries;
- Arctic policy and polar areas;
- Transport;
- Energy;
- Environmental compliance;
- Raw materials;
- Air quality and atmospheric composition;
- Health;
- Tourism;
- Climate Change;
- Civil protection and humanitarian aid operations;
- International development and cooperation;
- Migration and home affairs;
- Security;
- Research and innovation;
- Other.

### d) User sector of activity

Users will be asked to state their main target sector, using the following categories:

- Public sector (including policy support);
- Business sector;
- Research;
- Education;
- Media and public relations;
- Charities and NGOs;
- Private individuals for non-commercial purposes;
- Other.

AIG intends to implement an automated means for the Data Mirror Site to collect the required statistical information on Copernicus Sentinel data re-distribution and analysis, and

intends to cooperate with ESA on the technical means for ensuring such data is formatted/structured to ensure it is of maximum value.

It is highlighted that ESA may pass the information provided in the annual report to a third-party contractor for processing and analysis. The information and an analysis of the statistics will be sent to the European Commission and subsequently made publicly available.

AlG will design the user registration process so that the statistical information can be collected while preserving the anonymity of the user and in compliance with national and/or regional legislation for protecting the users' personal data. AlG will not disclose any personal data (i.e. information from which a natural person can be identified) of its Data Mirror Site users to ESA.

### 4.5 Sentinel Data Governance

Copernicus Sentinel data made available via the Copernicus Data Space Ecosystem, or equivalent Copernicus Sentinel data access service, are governed by the "Legal notice on the use of Copernicus Sentinel Data and Service Information", a copy of which is appended to this TOA at Annex D.

In the event that the EU, in the future, designates Copernicus Sentinel data as "sensitive"<sup>1</sup>, the access to such Copernicus Sentinel data through the Copernicus Data Space Ecosystem or equivalent Copernicus Sentinel data access service, and its use and distribution may be subject to different licensing conditions.

This also applies for Copernicus Sentinel data already received by AIG or a partner through the Copernicus Data Space Ecosystem or equivalent Copernicus Sentinel data access service, in the event the Copernicus Sentinel data are assessed to be "sensitive" after the time of data download.

Where Copernicus Sentinel data are identified as "sensitive", AIG will endeavour to remove such data from the Data Mirror Site. It is understood that AIG will be unable to retract data which has already been re-distributed.

## 5 INTERNATIONAL COMPLEMENTARY EXTERNAL VALIDATION SUPPORT

<sup>&</sup>lt;sup>1</sup> As defined in Art. 13 of the COMMISSION DELEGATED REGULATION (EU) no 1159/2013 of 12 July 2013 supplementing Regulation (EU) No 911/2010 of the European Parliament and of the Council of the European Earth monitoring programme (GMES) by establishing registration and licensing conditions for GMES users and defining criteria for restricting access to GMES dedicated data and GMES service information.

### 5.1 AIG Activity

AIG intends to facilitate complementary Copernicus Sentinel data calibration and/ or validation activities in collaboration with ESA, with the aim of improving the quality of both core Copernicus Sentinel core user-level data and of derived higher-level user-level data.

Copernicus Sentinel data required for those projects may be supplied directly from the Copernicus Data Space Ecosystem to the project, or from the Data Mirror Site. In the latter case, reporting and data governance are handled as per Sections 4.4 and 4.5 above.

AIG may conduct these calibration/validation projects together with partner entities. In such a case, AIG will act as the interface and contact point between ESA and the other entity.

Details of on-going and planned calibration/validation projects are described in separate documents, describing the involved entities, the scope of the calibration/validation project, applied methodology, expected results and related use/licence conditions, geographic area of interest, mechanism for supply of Copernicus Sentinel data, time schedule and reporting.

Annex B contains a list of the currently on-going and planned projects. Annex B will be updated as and when necessary.

# 5.2 ESA technical support to complementary validation activity

ESA will provide relevant data sets from the Sentinel -1, -2, -3 and -5p core user-level data (i.e. L1 and L2. In special cases also L0) as they become available, to support joint validation and calibration activities.

### 5.3 Reporting

Reporting regarding the complementary external validation activities will be defined in the related separate technical documentation.

## 5.4 Copernicus Sentinel Data Governance

Copernicus Sentinel data used by the complementary validation activity are governed by the "Legal notice on the use of Copernicus Sentinel Data and Service Information.", a copy of which is attached to this TOA at Annex D.

### 6 DISCLAIMER

6.1 Access to data from the Copernicus Sentinel missions is on an "as is" basis. ESA disclaims all conditions, representations and warranties of any kind, whether express, implied statutory or otherwise, including but not limited to what concerns the functionalities of the Copernicus Data Space Ecosystem or equivalent Copernicus Sentinel data access service, and the data transferred. This disclaimer includes the warranties regarding

availability, continuity, accuracy, integrity, reliability, fitness for or compatibility with a particular purpose or meeting the users' requirements, satisfactory results or non-infringement of third-party rights.

- 6.2 ESA will not be held liable for any damage that may result from the support activities provided under this TOA, including in particular the functionalities of the Copernicus Data Space Ecosystem or equivalent Copernicus Sentinel data access service, the data transfer, and advice and communication by ESA personnel.
- 6.3 ESA may at any time review, modify, suspend or terminate the support activities under this TOA, including but not limited to on the occurrence of the following events:
- lack of sufficient funding for sustaining the Copernicus Sentinel missions, and associated facilities and activities;
- (ii) satellite or ground system failure; or
- (iii) suspension or cancellation of planned activities of related Copernicus Sentinel systems and facilities, in order for ESA or the EU to carry out activities considered of a higher priority.
- 6.4 ESA may modify the Copernicus Sentinels' operations plans at any time, according to operational priorities or if it considers corrective action is necessary for ensuring the safety and success of the missions.

### Annex A. Map of region of interest

The map below represents the region of interest for AIG at the date of signing the TOA. The scope of the geographic region for which data will be retrieved/stored/re-distributed may be changed when required, with a notification sent to ESA.

The area of interest is the geographic region of Latin America and the Caribbean. It is assumed that AIG will scale up the infrastructure on a step-by-step basis to be able to host and process coverage of this full area.



Created with mapchart net

### Annex B. Complementary External Validation Support Projects

Below is a list of the currently on-going and planned projects aimed at complementary Copernicus Sentinel data calibration and/ or validation activities in collaboration between AIG and ESA with the aim of improving the quality of both core Copernicus Sentinel core user-level data and of derived higher-level user-level data. This list may be updated at any time by written agreement of the signatories.

No activity planned at the date of signing the TOA.

Annex C. CSC Operations - ESA Framework - Operations Concept in its latest version at the date of signature: Issue 1.1, ESA- EOPG-EOPGC-TN-19, dated 27 September 2022





# **DOCUMENT**

**CSC Operations - ESA Framework - Operations Concept** 

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### 1 EXECUTIVE SUMMARY

The overall system architecture for the Copernicus Space Component (CSC) and its evolution have been defined on the basis of user requirements coordinated by the European Commission. The Long-Term Scenario (LTS) describes the main elements of this architecture and is maintained and evolved in an iterative process in close interaction with the European Commission (COM), EUMETSAT and Copernicus Participating States.

ESA needs to guarantee the continuity of the on-going operations with the maximum level of performances for the flying Copernicus Sentinels while facing the technical and financial challenges to adapt to the evolutions of the CSC architecture.

A transformation process for the CSC GS was established in 2018 in based on a clear set of principles and a target architecture. Referred hereafter as the ESA Operations Framework (EOF).

The EOF encompasses all the activities necessary to successfully deliver the expected level of CSC operations entrusted to ESA (i.e. establishment and maintenance of the new baseline, procurement actions, operations management, reporting, etc.).

The EOF is documented throughout a complete package describing and specifying the applicable operational concepts as well as the architecture and procurement evolutions to be adopted for establishing the future CSC operations baseline (in particular with respects to the future Expansion Missions, associated with the necessary cost information to size the proposed approach and potential trade-offs).

The EOF implementation is based on service architecture with well-identified components that exchange data through Internet respecting defined interfaces. A service presents a simple interface to its consumer that abstracts away the underlying complexity. Combined with deployments on public cloud infrastructure, the service approach shall offer large adaptability to evolution of the operational scenarios in particular for what regards scalability.

Since 2019, the Copernicus ground segment operations have been transferred to cloud based environments (in anticipation of the enlargement of the Copernicus Sentinel missions and in response to the ever-increasing demand for Copernicus data) and the service-oriented approach for each component of the CSC ground

The individual Service Operations Dashboard are meant to monitor the individual service performance as a tool for the service operations management and as an essential input to the end-to-end operations performance monitoring service.

The end-to-end operations performance dashboard, providing an integrated view of the operations performance in time, is meant to serve as a tool for the overall operations management by ESA but also to provide an up-to-date transparent status of the operations performance to CSC users and stakeholders.

### Link between performance and service cost

The CSC Operations concept foresees a direct link between the effectively achieved operations performance by each individual service and the corresponding service cost.

The CSC Operations performance monitoring through the associated KPIs for each service provide as well an indication of the industrial service provider performance.

The KPIs for a given CSC operational service are associated to different levels of performance. There are typically 5 performance levels associated to each KPI, from the maximum full performance level to the underperformance level, and each performance level is associated to a cost modulation factor.

Service operations KPIs are measured continuously and averaged on a monthly basis. The performance level achieved on a given month defines the cost modulation factor to be applied to the service monthly cost.

The KPIs and associated cost modulation for each service are established through a dedicated Service Level Agreement (SLA) between ESA and the Service provider.

### Operations performance benchmarking

As part of the CSC Operations concept, ESA is independently measuring the competitiveness and performance of the CSC Ground Segment operational services and of the services offered to users.

The benchmarking of the services offered to users includes the CSC services managed by ESA (e.g. data access services managed by ESA) and potentially equivalent available commercial services.

The benchmarking of the service operations includes the definition of a set of performance indicators and the establishment of a transparent and documented measurement process, allowing the full reproducibility of the performance measurements.

segment operations has been strengthened to enhance competitiveness, prevent industrial and technical lockin and introduce the necessary operational flexibility and transparency to allow the adaptation of the Copernicus Ground Segment to future challenges.

Within this context, this document outlines the organization and principles of the CSC ESA operations. This Operations Concept describes the overall Sentinels operations set-up, from satellite commanding to the data acquisition, production, archiving and data access. The Operations Concept defines also the process for the operations implementation, procurement and management as well as the approach for maximising the operations performance for mission exploitation in adequacy with the needs and the available resources.

### 2 INTRODUCTION

### 2.1 Purpose of this document

This document provides an end-to-end overview of the Copernicus Space Component Operations Concept, according to the timeline of the ESA and EU programmatic and budgetary planning and in particular for the reference period 2022 to Q1 2028 of the Copernicus Contribution Agreement (MFF-2).

### 2.2 Document context

The present document is part of the CSC operations baseline issued by ESA in the overall context of the Copernicus Programme documentation baseline as illustrated in the figure below:

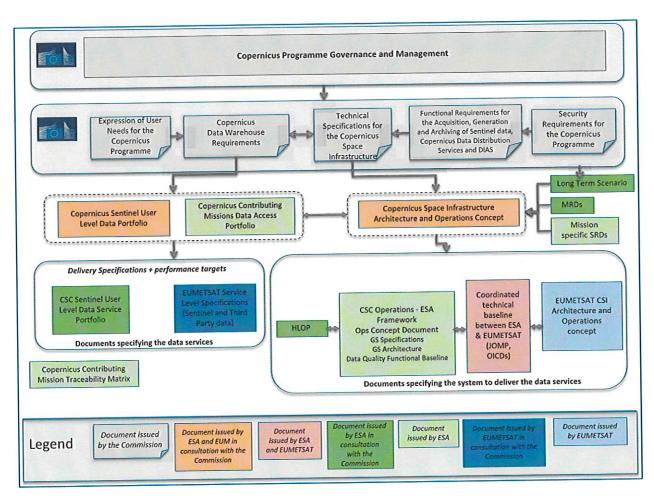


Figure 1: Copernicus operations documentation context

# 2.3 Applicable and Reference Documents

### 2.3.1 Applicable Documents

[AD-SPC]

CSC Operations - ESA Framework - Specifications [ESA-EOPG-EOPGC-RS-1]

### 2.3.2 Reference Documents

[RD-HLRM]

CSC Operations - ESA Framework - High Level Roadmap [ESA-EOPG-EOPGC-PL-

6]

[RD-IMP]

CSC Operations - ESA Framework - Ground Segment Evolution Implementation

Report [ESA-EOPG-EOPGC-PL-7]

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CSC Operations - ESA Framework - Operations Concept

[RD-STB]	CSC Operations - ESA Framework - System Technical Budget [ESA-EOPG-EOPGC-TN-09]
[RD-OBS]	CSC - ESA Ground Segment Operations Framework: Copernicus Sentinels Observation Strategy - Implementation [ESA-EOPG-EOPGC-TN-08]
[RD-MICD]	CSC Operations - ESA Framework - Master ICD [ESA-EOPG-EOPGC-IF-06]
[RD-ESA_EUM_COOP]	Concept for the Cooperation of ESA and EUMETSAT regarding Copernicus Evolutions co-signed by J. Aschbacher (ESA) & A. Ratier (EUMETSAT), 2017
[RD-DP]	Sentinels User Level Data Portfolio [ESA-EOPG-EOPGC-TN-20]
[RD-GLO]	CSC Ground Segment Operations Framework Glossary [ESA-EOPG-EOPGC-TN-13]
[RD-ADD]	CSC Operations - ESA Framework - Ground Segment Architecture [ESA-EOPG-EOPGC-TN-7]
[RD-DSP]	CSC Operations - ESA Framework - Data Access Services Portfolio [ESA-EOPG-EOPGC-TN-57]
[RD-DQFB]	CSC Data Quality Functional Baseline [ESA-EOPG-EOPGM-TN-1]

# 2.4 Acronyms and Definitions

Please refer to [RD-GLO]

## 2.5 Document organisation

Section 1 is an executive summary of the ESA Copernicus Ground Segment Operations Framework.

Section 2 provides the introduction and the scope of the ESA Copernicus Ground Segment Operations Framework, the Applicable Documents and organisation of the Operations Concept document

Section 3 & 4 recaps the Operations Scope and the key objectives and principles of the ESA CSC Operations Framework

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European Space Agency Agence spatiale européenne Section 5 & 6 – introduce the procurement of the services and the management associated to budget & cost control.

Section 7 provide highlights on the data cycle, and transversal aspects like security and traceability.

Section 8 introduce the Collaborative interfaces.

Section 9 & 10 provides details on the future integration of the C&D units and Sentinels Expansion missions. Further details are provided in the High Level Roadmap [RD-HLRM].

All relevant assumptions for the Operations Concept are set out in the ESA CSC Ground Segment Operations Framework Specifications [AD-SPC] and System Budget [RD-STB].

# 3 ESA CSC OPERATIONS RESPONSIBILITIES AND TIMELINE

Copernicus is a jointly funded programme delivered in partnership between the European Union and ESA. The ESA-funded programmes and activities are planned and implemented in close coordination with the tasks funded by the EU and entrusted to ESA.

In this context, the European Commission relies on ESA for the development and procurement of the Copernicus satellites, for the development and procurement of the ground segment and the flight operations segment and for the operations of a number of dedicated Copernicus missions.

Out of these activities, the CSC mission operations are funded by the European Union while the development of the mission specific elements is funded by ESA CSC-4 Programme. The mission specific elements include typically the mission planning systems, the operational data processors and the associated calibration and validation tools.

The Copernicus Programme foresees the long-term continuation of the Sentinel-1/2/3 missions with the launch of 2 additional satellite units (C&D) in the coming years, and a number of Sentinel expansion missions and next generation missions to be prepared during the present period (2022-Q1 2028).

For the present reference period, 2022-Q1 2028, ESA is responsible for the continuation of the Sentinel mission operations, for the preparation of the Copernicus Expansion mission operations. The operations of the future Copernicus expansion missions are expected to start in the 2025-2026 timeframe for CO2M and from 2028 onwards for the other missions.

More precisely, for the present reference period, 2022-Q1 2028, ESA is responsible for the continuation of the operations of the following Sentinel missions:

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- Sentinel-1, with two units simultaneously in routine operations, and for a limited time period (typically 3 to 6 months) a third unit in Commissioning Phase<sup>1</sup>;
  - Sentinel-2, with two units (A&B) simultaneously in routine operations, and for a limited time period (typically 3 to 6 months) a third unit (C) in Commissioning Phase;
  - Sentinel-3(land), with two units (A&B) simultaneously in routine operations, and for a limited time period (typically 3 to 6 months) a third unit (C) in Commissioning Phase.
     Sentinel-3 is jointly operated with EUMETSAT, operating the Sentinel-3 marine mission;
  - Sentinel-5P, in routine operations (at least until 2026);

For these missions, the ESA operations responsibility covers the following main areas:

- · Satellite in orbit maintenance;
- Satellite operations, including TT&C, satellite monitoring, flight dynamics and debris monitoring by the Flight Operations Segment;
- The definition and implementation of the mission observation scenario, including instrument and satellite downlink planning, data acquisition operations, data processing to generate user level data, data archiving and distribution by the CSC Ground Segment;
- The Quality Control of the CSC user delivered data, including the calibration and validation of the data processing algorithms."
- The free and open access to the Sentinel user level data.

The operations of the future Copernicus expansion missions are expected to start in the 2025-2026 time frame for CO2M and from 2028 for the other missions.

In addition, for the present reference period, 2022-Q1 2028, ESA will contribute to the CO2M operations, jointly with EUMETSAT, in terms of:

<sup>&</sup>lt;sup>1</sup> For the case of Sentinel-1, a period with one satellite only in routine operations is expected from end 2021 until the launch of Sentinel-1C planned in 2023.

- Flight operations following launch until hand-over to EUMETSAT;
- Satellite in orbit maintenance;
- Ka-Band data acquisition and provision to EUMETSAT for subsequentprocessing, archiving and distribution operations.

## 4 GENERAL CSC OPERATIONS GUIDING PRINCIPLES

The CSC Operations for the current phase of the Copernicus Programme build on the achievements and the experience gathered during the initial operations phase, 2014-2021, with the necessary evolutions to cope with the challenges associated to the increasing data volumes to be managed, to the evolving user scenario and to the budgetary constraints.

The CSC operations are to be considered in the following wider context of the Copernicus Programme:

- Copernicus will continue to be a public operational service with a free and open data policy to ensure long-term provision of observations from space.
- Copernicus will ensure the continuity of the current Sentinel observations, guaranteeing continuity to the operational services and commercial operations relying on the availability of the Sentinel data.
- The evolving needs of the Copernicus services, the user requirements and the EU policies remain the key driver for the evolution of the CSC operations in support the global societal challenges
- As Copernicus evolves it will also increase the impact on the Space Economy, i.e. foster the
  geospatial information market and EO-related initiatives in Europe creating growth, business
  and innovation. The DIAS initiative has contributed to progress in this direction and it is
  expected to remain a key element in the future Copernicus context.
- The CSC will offer an end-to-end system that combines the capacities of the CSC Sentinels with European national investments, both private and public.
- Partnerships and cooperation will be pursued as instruments to complement the Copernicus capabilities and to reaffirm the leadership role of Europe as a key global actor.

New European endeavours like Destination Earth (DestinE) initiative will further push
Copernicus to a leading role in the generation of key data and information in support to EU
policies and the European Green Deal objectives in particular. DestinE creates create new
challenges for Copernicus in terms of data availability, data quality, long term data series
coherency and data access performances.

The need to secure the financial affordability of the CSC operations is calling for a streamlining
of the operations and novel approaches to reduce the operational costs while maintaining high
service standards.

Within this context, the CSC services for the timeframe 2022 to Q1 2028 are to be seen in continuation of the first period with the aim to increase the operational robustness and capacity at increased efficiency in order to keep the CSC operations sustainable.

In order to cope with these anticipated challenges, the CSC operations have undergone a transformation process in close interaction with the Commission and Member States.

The evolved operations concept allows to reduce the cost in view of a cumulative data increase and its corresponding cost increase and also to maintain a satisfying service level for the users while their number and the data volumes at their disposal is drastically increasing.

This evolved CSC operations concept relies on the following principles:

 Empower European industry to deliver high standard CSC services and keep a leading role in EO activities and operations while maintaining industrial competition:

 Re-organise the CSC operational activities by re-defining the scope and boundaries of the CSC services to match existing standard industrial services for cost efficiency through increased competition

 Re-organise the operations procurement approach to ease the transfer of CSC service operations among companies through the various procurement cycles, counteracting industrial lock-in

- Increase the transparency and predictability of the operations costs by establishing a parametric model, applied to each industrial service contributing to the CSC operations. allowing in addition to tailor the operations capacity and performance to the available resources and requirements.
- Benefit from state-of-the-art technology solutions in terms of flexibility, scalability and performance without upfront infrastructure investments by maximizing the usage of cloud environments for the CSC operations.
- Increase the operations efficiency by streamlining and harmonizing the operational interfaces
  across services and among missions, making use of internet and cloud environments
  andoptimizing the integration effort of new satellite units for on-going missions and the
  integration of futuremissions into the operations.
- Stimulate and benefit from synergies with existing complementary industrial services, while assuring free and open data access to core user level data.

As part of the evolved CSC operations concept, the CSC operations have drastically evolved from an architecture based on hardware assets to a concept of remotely managed virtual service instances, fostering the automation and the reduction of the operations manpower by the service providers.

# 5 CSC OPERATIONS PROCUREMENT PRINCIPLES

As part of its role in the Copernicus programme, ESA manages the CSC operations and outsources a number of operational services to industry, aiming at increasing industrial involvement and responsibility:

- The CSC end-to-end operations management and the management of the CSC industrial services are considered an institutional responsibility and performed directly by ESA.
- The day-to-day spacecraft monitoring and control activities are considered an institutional responsibility and performed directly by ESA.
- The satellite maintenance activities are outsourced to industry, as follow-up contracts with the satellite and instrument development manufacturers.

European Space Agency Agence spatiale européenne Ground segment operations, data access and calibration & validation functions are outsourced
to industry in the form of service-oriented contracts based on a cost model and a Service Level
Agreement with cost modulated as a function of performance

The outsourcing of CSC operations is implemented via large scale service contracts serving all Sentinels, embedding the principles of increased industrial responsibility, increased industrial competition and increased flexibility for service provider selection.

These principles are implemented as part of the service procurement process, in particular the following logic is considered:

- CSC operations are procured in the form of operational services, managed through a Service Level Agreement and a Cost Model
- The Service Level Agreement defines a set of Key performance Indicators suitable for monitoring the service performances and a set of associated performance and cost modulation levels
- The Cost Model provides a direct link between the service operational capacity and operations load and the service cost. It allows adjusting transparently the service resources according to the needs and required performance.

Different approaches are followed for the procurement of the CSC operations services, depending on the service type (mission specific, transversal service, etc.). The CSC procurements and associated procurement approach is subject to the approval by the European Commission.

#### 6 EOF COST MANAGEMENT

EOF operations are organised within the boundaries defined by the EU budget framework, the definition and the cost of the services to be delivered and associated performances. The success of the EOF operations is therefore the result of the adequate management all along the budgetary period of the resource consumption together with the provision of services satisfying user expectation and fulfilling the required tasks.

Copernicus operations are very large and the figures extracted from the ESA data access report 2021 are clearly demonstrating the constant increase of the volume to be managed through the years.

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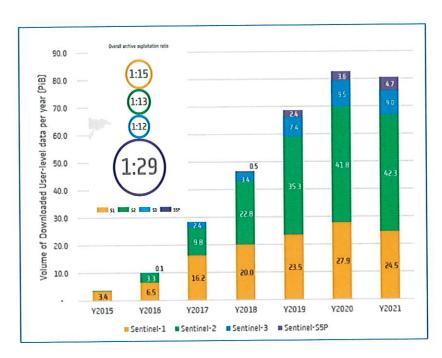


Figure 2: ESA EOF data dissemination ratio

This volume and its increase trend are already indicating that the profile of the resources consumption needs to be managed preserving resources towards the end of the budgetary period (nominally, more than 2/3 of the budget are required for the second half period).

A lower range of data volume would allow for easier planning and easier adaptation to user requests. Operations within the range of few PBs may be organised with standard infrastructure and exploiting system margins.

The EOF has been conceived to allow dynamic adjustment and support long term planning. Strategies for control and allocation management can be prepared on the basis of modelling and analytics. The following sections are introducing the principle for such management. The cost models from industry cannot be disclosed but the overall approach is presented to support the effort of good planning and good practices from industry.

### 6.1 Fixed and variable resources

Given a known CSC operational scenario, the CSC operations capacity and performance should be configured accordingly.

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CSC Operations - ESA Framework - Operations Concept

European Space Agency Agence spatiale européenne The CSC operational scenario may be established for most of the operational functions, leading to a given necessary capacity, pre-defined and almost fixed level of resources consumption. This is the case in particular for:

The satellite data acquisition operations: for a given set of satellite units in operations, and a
fixed observation scenario, the number of downlink passes required to acquire all mission data
can be precisely determined.

 The data production operations: for a given set of satellite units in operations, a fixed observation scenario (i.e. a fixed amount of acquired data) and a fixed set of data to be produced with a fixed timeliness requirements, then the production resources and effort can be sized precisely.

 The mission data preservation operations: for a given set of satellite units in operations, a fixed observation scenario (i.e. a fixed amount of acquired data) and a fixed set of data to be produced, then the archiving resources for the long term preservation of the lower level mission data can be sized precisely.

Nevertheless, for other operational functions, in particular the user data access, considering that the user scenario is not known in advance, the necessary resources to achieve a given performance cannot be determined a priory. This situation is leading to an uncertainty and potential variations in operations performance and user expectation or satisfaction. In case of user demand increase, the objective to keep the same level of satisfaction that is indirectly assessed through the time it takes to users to retrieve data requires to vary the level of resources like available bandwidth or on-line volume.

The future user scenario necessary to size the data access operations is an unknown and depend of quality of service but also to external factors like alternative satellite data or access services. However, the operational experience gathered so far and the measured evolution of the user scenario over the past years provides a well-grounded basis for the overall sizing of the future data access operations. The allocation of a fixed level of resources for the user data access will be sufficient to guarantee open, full and free access to the Sentinel user level data.

The operations configuration associated to the variable data access element include a wide range of sizing parameters impacting the final experienced user data access performance. This includes typically the data access bandwidth allocated to the data access services but also the volume of data available on-

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line for immediate access, the resources available for on-demand processing, the performance in the retrieval of the lower-level data from the Long-Term Archive and thus the number of available sources for the lower data retrieval, etc. The key sizing parameters for the management of the data access operations are defined in the Data Access Services Portfolio [RD-DSP].

The logic is illustrated in the graph below:

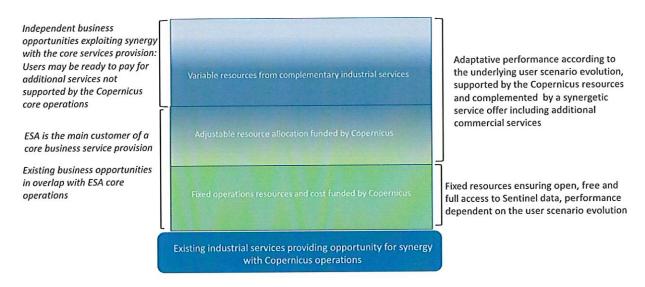


Figure 3: Fixed and variable resources

### 6.2 Budget control

According to the above, the EOF cost modelling requires that several elements are considered all together:

- An operational scenario defining the key parameters characterizing the performances and analysing fixed and variable resources usage
  - The scenario can be related to parameters like number of acquisitions, volume of data produced by orbit that are mission dependent or that can be controlled by exploitation decisions and parameters outside the reach of ESA control like the number of active users over a period.
- A reference service cost model defining the key parameters for the cost evolution

- The Ground Segment services costs are integrating costs that are made of elements related to the direct IT consumption of resources (e.g. volume of data, compute requirement) as well as elements related to the maintenance of the service in operation like man-power, corrective and evolutive maintenance.
- The service costs are established by industry through a competitive process. The experience gained in 2021-2022 shows the large range of service models and the diversity that exist in industrial models and solutions. It is noted as well that the cost of a service is not to be assimilated to the cost and evolution of the IT underlying component as the man-power and the maintenance are still representing a significative fraction of the cost.
- The relation between operational parameters and service parameters
  - The operational scenario needs to be combined into a model of cost that can be used to support the definition of a multi-years budget and the regular management all along the project lifetime to monitor and adapt resources consumption.
- The applicability of the scenario and risk associated to evolution through time (e.g. economic conditions, market price evolution...)
  - O Any scenario is embedding variability and risks. The MRD defined for the development of some missions and used for the initial budget sizing have been largely evolved through time and associated resources increased. At the start of the missions the user scenario has been completely underestimated and only careful planning including strong quota adoptions have made possible the delivered quality of service.

The adjustment of the performances to the available resource is an iterative process (see Fig.4), the cost modelling is supporting the decision-making process in offering a mid-term provisional view to avoid brutal shortage in case of resources overconsumption.

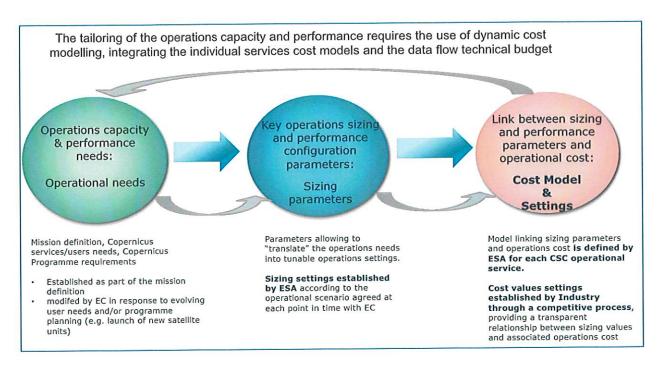


Figure 4: Cost model and operations sizing and performance

#### 6.3 Synergy with complementary industrial services

The EOF concept creates a large European ecosystem of autonomous and independent industrial EO services. The standardisation of the interfaces and the strong service approach are fostering potential reuse of solutions. In addition, synergies exist with complementary industrial services like provision of new user data, offering of local resources for user to implement their own production chain or services.

The current framework did not support the opening of Ground Segment interfaces to industrial partners outside the scope of the core operations. ESA and the European Commission are engaged into the process of consolidating such approach to avoid duplication and favour synergies to expand the data access operations capacity and performance beyond the level financed by the Copernicus Programme. Such operations have to be performed in full respect of the European regulations, careful review of the terms and conditions is to be continuously ensured.

## 6.4 Tailoring of operations capacity and performance

The new ground segment operations architecture inherits the scalability and flexibility from the use of up-to-date IT technologies. This new paradigm, together with the use of parametric cost models for the

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service operations, allows tailoring the operations capacity and performances to the available resources and requirements.

The operational scenario requires the interaction between the main programme stakeholders and involves the following actors:

- COM as stakeholder for the EOF CSC operations
- Industry, as service provider for the EOF CSC operations (multiple service providers are expected)
- User, as EOF CSC final user, interacting with the service provider

The following diagram illustrates the end-to-end process from the establishment of the available CSC operations resources, to the configuration of the operational parameters in line with the resources, the resulting user experience and the potential role of industry (as service provider) to enhance the user experience.

The CSC operations resources are established by the European Commission as part of the overall delegation process. The EOF is designed to be able to adapt the CSC operations services capacity and performance according to the available resources, through the configuration of key operational parameters. These key operational parameters are those driving the operations cost and the EOF strategy (in terms of design, procurement and implementation) allows tuning them without impacting the operations implementation.

The available CSC operations resources are translated into a set of operations parameters establishing the performance of the free and open services provided by the Copernicus Programme.

The Industrial service provider may offer additional services to users, complementing or extending the free services supported by Copernicus (e.g. ad-hoc performance, tailored data access services, etc.).

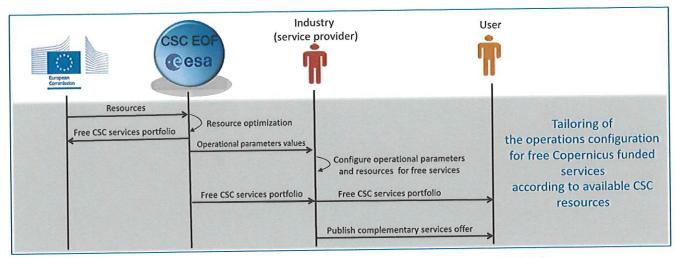


Figure 3. Adaptation of operations configuration for free and open services to the available CSC resources

# 6.5 EOF Cost Management – an example – Data Access

The Data Access sizing is one of the most critical elements of the Copernicus EOF, the challenge to be addressed is directly linked to the perceived success of the Sentinels operations.

The system budget (see [RD-STB]) indicates a total of about 100PiB of data to be considered at the end of the current period (2022 – Q1 2028).

In order to size the service, one of the key parameters is related to the exploitation ratio which is defined by the volume downloaded divided by the volume published. The following representation illustrates the variation of the exploitation ratio through time and the corresponding linear extrapolation until Q1-2028. An exploitation ratio of 30 seems quite high as it corresponds to 30 times the download of every single product, still it is to be acknowledged that reprocessing campaigns may lead to massive new downloads, it is therefore very likely that this parameter can be lowered in the estimate but that the current value has not yet reached its maximum. A conservative value of 20 is therefore considered.

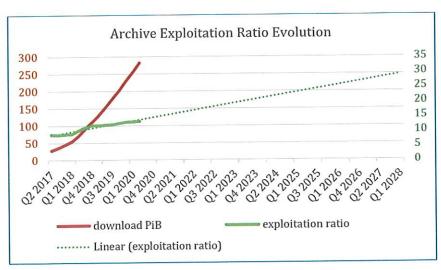


Figure 4. Evolution of the archive exploitation ratio and downloaded data volumes

In a very direct approximation and focusing on the download, the current cost of the service corresponds to an exploitation of 14 and an available data volume of 30PB. Under a linear scenario, the budget for the data access download function should be about 5 times higher than the cost incurred during the previous period.

Such increase is also at the limit of the programme sustainability and explains the need to rationalise the function and to favour the development of complementary services that would limit the download needs.

Yearly provisions can be made following the evolutions of the download ratio and published volume. The quota allocated to users can be adapted according to the process to tailor operations performances and resources.

## 7 CSC OPERATIONS CONCEPT HIGHLIGHTS

#### 7.1 CSC Sentinels Missions Users

In addition to the world wide large public served on a best effort approach basis but that constitutes in its entirety one of the most demanding user category in terms of resources, the EOF operations concept assumes that the following classes of users will get dedicated access to the Sentinel user level data through the CSC operations managed by ESA:

- Copernicus Services
- Union institutions and bodies

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- o National or regional public authorities in the European Union or Copernicus participating states
- Collaborative Ground Segment Partners and International Partners having established agreements with EC/ESA (see section 8)

Mission interfaces, access rights and quotas may be different for different classes of users. The available interfaces, access rights and performance are described in the CSC Data Access Services Portfolio [RD-DSP].

User information is gathered for statistical reporting purposes to support analysis of take-up of Copernicus (categories are proposed to be harmonised over all Copernicus information systems for affiliation, thematic interest, sector, geographic origin ...). User information is managed according to the relevant personal data policy regulations (both European (GDPR) and ESA policies), and in principle aim to request and retain the minimum set of user information necessary to fulfil the data distribution operations and reporting requirements. Self-registration is supported for the free access services, or mediated via help desk for those services with specific access conditions (e.g. access to greater quota, or temporary access for validation of a data during commissioning).

#### 7.2 CSC Data lifecycle

The CSC data lifecycle plays a central role in the management of the CSC operations, with major implications on the user experience, the operations sustainability and the long-term data exploitation. It involves a number of trade-offs to be regularly re-evaluated in view of the evolving user demand, the opportunities provided by the evolution of IT technology, the potential for increased synergy with industrial offers, etc.

A major benefit of the new CSC Ground Segment architecture is the possibility to modify the data lifecycle by means of operations configuration, with a transparent model to assess the associated cost and performance implications, without the need for a system redesign, asset investments or lengthy implementation schedules.

The main elements in the data lifecycle, the baseline operations scenario and the key configuration options are described hereafter:

 All data acquired by the Sentinel satellites and received at the acquisition stations is converted into a raw data stream (in the form of CADU data) and systematically processed by the

production services to a set of pre-defined data types, including engineering data required for e.g. calibration activities and user level data to be made available to users.

- The lower level data (Level-0) is systematically archived for long term preservation.
- The user level data systematically generated is made available "immediately" (in line with each data timeliness requirements) for on-line user data access and remains available for immediate on-line download for a configurable time period (rolling period). The rolling period may be dynamically adjusted according to the observed user activity, to the geographical area or type of data.
  - In some cases, the user level data may be processed with more than one timeliness requirement as improved auxiliary data (e.g. meteorology actuals vs. forecasts) are available. In such case the consolidated data generally replace the prior versions again according to a rolling policy.
- The consolidated version of the rolled-out data remains available for user discovery and download, ensuring access to all mission data. Different mechanisms are supported to ensure access to rolled out data, and operations configuration may be based on any combination of them:
  - Rolled out data is available in a storage with a different retrieval latency and same or different data access interfaces (typically as part of the LTA service operations or as part of the Data Access service operations)
  - Rolled out data is re-generated on the fly on user demand
  - o The data access performance for operations supported by Copernicus Programme may differ for rolled out data and for data available on line, in both cases depending on the allocated resources and user scenario. In both cases, the data access mechanisms and performance offered by Copernicus may be complemented by the industrial services operating the data access service. The operated performance and interfaces are documented in the Copernicus Data Services Portfolio.

In addition, bulk reprocessing campaigns for a mission data period or a specific data type are envisaged in order to ensure availability of harmonised data series.

The reprocessed data are intended to be "re-integrated" in the data workflow for distribution via the Data Access Service. A basic assumption is that the reprocessed data sets will incrementally replace the previous version available to users (although more complex scenarios could be foreseen if there are compelling reasons to maintain more than one baseline). The publication on the Data Access Service will foresee the data being maintained online for a suitable period. All reprocessed data will be registered in traceability service. Reprocessing activities will be reported within the end-to-end monitoring under the umbrella of the operations coordination.

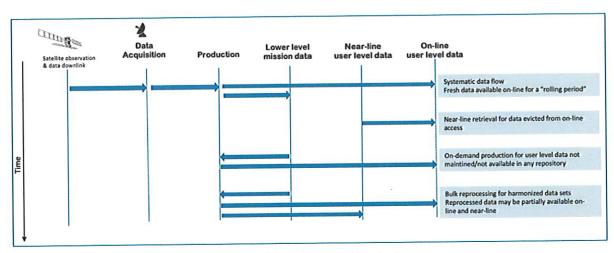


Figure 5. Data lifecycle illustration

#### 7.2.1 CSC Data traceability

To provide an authoritative record of all user level data produced within the EOF, traceability records are generated for all stages of the data lifecycle and are registered with the Traceability Service as outlined in [RD-ADD]. The traceability record consists of a cryptographic hash values for the user data accompanied by some standard metadata, the record is accompanied with a digital signature of the authorised service responsible for production / archive / distribution of the package. The Traceability Service allows end users to verify the authenticity and provenance of any Sentinel User Level Data via a graphic user interface or API: the user can use the same tool to calculate the cryptographic hash value for the user level product of interest and verify the existence of this within the service.

Both creation and deletion events are recorded within the Traceability Service, so the Traceability Service also provides the means to verify the completeness of Sentinel Data archive holdings, e.g. from a mirror archive.

# 7.3 CSC Complementary data access points

The EOF architecture and workflows are built upon well separated functional building blocks (operational services) offering standard access points. Every service is offering a scalable pick-up point based on similar data models and with similar capabilities for data selection and retrieval. The pick-up point is hosted on a public cloud with an internet access. This approach is enabling a strong decoupling between the provider of the data at the interface point and the consumer(s) of the data.

The EOF architecture is therefore streamlining the communication between operational services and supporting the possibility to offer complementary data access points all along the Ground Segment operational workflow (e.g. at the CADU data acquired by the acquisition stations, at the data generated by the production services encompassing user level data and engineering data, at the data retrieved from the Long Term Archives, etc.). This feature is being used naturally by the Ground Segment for operating an end-to-end data workflow through a chain of services, for the transparent integration of new services or smooth change of service providers, for data sampling for analysis, for a smooth change of service providers, etc.

In addition, it is planned to give access to these complementary access points to operational ground segment services that are part of a frame contract, with the objective of allowing them to maintain their service in-line with ESA specifications but also for their own needs and potentially for their own commercial services upon request and authorisation by the European Commission.

# 7.4 CSC Data Access Service and Copernicus Data Space

The Copernicus data access service for the period 2014 – 2021 was mainly based on an on-line data rolling archive complemented by access to the long-term archive.

In addition, the data access was based on a centralised service creating a single point of failure (note: internal redundancy of servers has been implemented to mitigate the associated risk) and bottlenecks to the distribution system.

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This traditional data access approach has been demonstrated too constrained by the operational limitation of a data workflow reusing systems meant to preserve the data that are not conceived to serve fast access to thousands of parallel requests.

In the other side, the DIAS initiative has demonstrated that ease of user exploitation of the Sentinel data can be considerably enhanced through the provision of compute resources local to the data holdings. In addition, in many cases, the DIAS have progressively built some large datasets including sometime the Copernicus CSC historical data baseline and Copernicus services information to provide access on-line or near-line.

The data access for the period 2022 – 2027 will benefit from the DIAS lessons learnt to provide enhanced access and services to the users while maintaining the boundary of the core operations.

Thanks to the new architecture, the operations of the data access service for the period 2022 – 2027 will be based on new services favouring the synergy with complementary services (e.g. the offering of computing resources collocated with the data offer), the completeness of the Sentinels data offer and the performances of the data access.

The CSC Data Access Service is tailored towards different user typologies with well-established configurations in terms of registration policy, data offer and access and download quotas as described in Data Access Services Portfolio [RD-DP].

The CSC Data Access Service is conceived as an element of an ecosystem, the Copernicus Data Space, consisting of services, tools and functionalities, bringing together IT and EO European actors, aiming at enhancing the end-user experience, limiting commercial and technical lock-in, maximising performances, and fostering the development of Third-Party EO initiatives.

Such an ecosystem is expected to support long term user operations and development of new European initiatives like Destination Earth.

The CSC Data Access Service operations will embedding transparent CSC Data Access Service redundancy, ensuring integrated data access with back-end and front-end services managed within a public cloud environment, and providing the capability to organise competitions for potential additional services.

It is noted that the transition to the new data access could create some backward incompatibilities with the current service. Special care will be taken to provide enough overlap between the different

operations to accompany the users in the transition. A special case could probably be the need to register to the new services or to reuse non-Copernicus accounts activated in the frame of complementary services.

## 7.5 CSC Operations performance

The objective of the CSC Operations may be summarised as the need to implement the mission observation scenario and make available the resulting user level data in line with the quality specifications. Accordingly, the CSC Operations performance provides a measure of the fulfilment of these objectives.

The CSC Operations performance is measured continuously at each operational level and integrated into an overall end to end operations performance in order to timely identify potential deviations, define mitigation or corrective actions and restore as early as possible the nominal level of performance.

The measurement of the operations performance for each operational service contributing to the overall operations is part of the service scope, in line with the services boundaries and objectives, and is performed based on a set of well-defined Key Performance Indicators (KPIs) defined by ESA and imposed to all industrial providers of the same operational service (e.g. KPIs are the same for all X-Band acquisition service providers) and common to all CSC mission operations (e.g. X-Band acquisition service KPIs are the same for Sentinel-1/2/3 data acquisition).

The end-to-end operations performance monitoring service aims at providing an integrated view of the CSC operations at different levels (including at mission level and at service level) and through time. This requires accessing the outcome of the operations at each stage of the process, from downlink to data availability, and collecting the operations performance measures from each individual service.

The end-to-end operations performance monitoring is based in particular on the following services:

- Satellite and flight operations performance, providing an indication of the spacecraft and instrument operations availability, including satellite downlink communications;
- Acquisition operations performance, providing an indication of how much the data downlinked by the satellite has been effectively and correctly acquired on ground, including the delivery of the satellite data stream on a delivery point within the expected timeliness;

 Production operations performance, providing an indication of how much the data acquired by the acquisition service has been effectively converted user level data, including the delivery of

the resulting user level data on a delivery point within the expected timeliness;

Long Term Archiving operations performance, providing an indication of how much the data

foreseen to be preserved for the long term has been correctly archived, and how effectively it

can be retrieved;

Data quality and calibration & validation operations performance, providing an indication of

how much the user level data meet the quality requirements, including the calibration and

validation accuracy;

Data Access operations performance, as the visible iceberg of the ground segment operations,

providing an indication of the user level data availability and access latency.

The implemented observation scenario defines the expected instrument operations and thus, the

resulting user level data to be made available to users. The end-to-end operations performance is mainly

based on the comparison between the implemented observation scenario and the user level data made

available to users and the time at which it has been made available after the satellite observation. The

integrated end-to-end operations performance view allows in addition the identification of the source

of the anomaly in case not all expected data is made available or in case not all data is made available

with the expected timeliness.

This approach allows the independent and autonomous measurement of the service operations

performance by each individual service, which is at the basis of the service operations management and

control necessary to avoid potential endless disputes of responsibilities in a distributed operations

architecture. And this without jeopardising the availability of an end-to-end view of the operations

performance.

Operations dashboard and performance

Each operational service contributing to the CSC operations, operates an interactive performance

monitoring dashboard providing up to date measurements of the service KPIs and complementary

performance parameters.

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The individual Service Operations Dashboard are meant to monitor the individual service performance as a tool for the service operations management and as an essential input to the end-to-end operations

performance monitoring service.

The end-to-end operations performance dashboard, providing an integrated view of the operations performance

in time, is meant to serve as a tool for the overall operations management by ESA but also to provide an up-

to-date transparent status of the operations performance to CSC users and stakeholders.

Link between performance and service cost

The CSC Operations concept foresees a direct link between the effectively achieved operations

performance by each individual service and the corresponding service cost.

The CSC Operations performance monitoring through the associated KPIs for each service provide as

well an indication of the industrial service provider performance.

The KPIs for a given CSC operational service are associated to different levels of performance. There are

typically 5 performance levels associated to each KPI, from the maximum full performance level to the

underperformance level, and each performance level is associated to a cost modulation factor.

Service operations KPIs are measured continuously and averaged on a monthly basis. The performance

level achieved on a given month defines the cost modulation factor to be applied to the service monthly

cost.

The KPIs and associated cost modulation for each service are established through a dedicated Service Level

Agreement (SLA) between ESA and the Service provider.

Operations performance benchmarking

As part of the CSC Operations concept, ESA is independently measuring the competitiveness and

performance of the CSC Ground Segment operational services and of the services offered to users.

The benchmarking of the services offered to users includes the CSC services managed by ESA (e.g. data

access services managed by ESA) and potentially equivalent available commercial services.

The benchmarking of the service operations includes the definition of a set of performance indicators

and the establishment of a transparent and documented measurement process, allowing the full

reproducibility of the performance measurements.

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The aim of the operations benchmarking is to maintain a transparent and unbiased information on the level of performance delivered by the Copernicus operations.

#### 7.6 CSC Operations coordination

The CSC operations involve a large number of industrial services and elements, each contributing to the overall operations in accordance with the service scope and performance.

The CSC operations involve more than 30 different service providers & elements simultaneously contributing to the operations.

The orchestration of all involved services, including the coordination of anomalies occurring on one service and potentially impacting other services (e.g. in case of a satellite instrument anomaly resulting in the interruption of data acquisition, no data downlink signal will be detected by the ground stations and no user level data is expected to be generated and made available for the missed acquisitions), is performed through a set of procedures defined and maintained by ESA and implemented on a daily basis by a dedicated centralised coordination service.

The individual service operations are managed autonomously according to their own anomaly and configuration management procedures to the maximum possible extend and complemented with the ESA defined procedures in particular for all aspects requiring coordination with other services.

CSC Operations coordination concept foresees as well a centralised configuration control management for all elements directly managed by ESA, in particular the satellite operations configuration and the processing algorithms and data processors versioning.

# 7.7 CSC Operations security aspects

Security is an important aspect of the CSC Operations at different levels, with different implications and requiring a different management approach. From a top level perspective, the following main levels should be considered:

- Satellite operations security: Security of the satellite operations as source of all data at the entry of the system.
- CSC data access operations security: Security at the interface of the system with the users and underlying internal security of the system supporting the operations.

The satellite operations security is defined through the satellite design and the associated flight operations procedures. It encompasses in particular aspects related to:

• Ensuring in orbit satellite safety through debris monitoring and collision avoidance warnings

and manoeuvres;

 Ensuring safety of satellite commanding and control, in particular through the validation of mission planning and uplink commands against the satellite operations safety constrains and

through the availability and applicability of satellite anomaly management procedures;

Ensuring the availability of a backup flight operations centre ready to take over the satellite

command and control in case of major contingency scenario affecting the nominal flight

operations centre.

CSC data access operations security encompasses all processes associated necessary to deliver the final user level data to users, and includes the following main aspects further addressed in the sections below:

Access to the data downlinked by the satellite;

Access to the data generated by the CSC ground segment and underlying Ground Segment

operations security aspects;

User data management.

The CSC data access and ground segment operations security management concept is linked to the open

and free Sentinels data access policy. As such, CSC data access and ground segment operations security

is focussed on ensuring business continuity and identifying and managing operational vulnerabilities

rather than on guaranteeing secured or restricted access to the Sentinel data.

A secured or restricted access to the Sentinel data would require the operational implementation of a

separate data flow, subject to a completely different set of security measures and constrains. The

flexibility of the CSC Ground Segment architecture would allow the implementation of a parallel data

flow subject to a different set of measures with minimum impact on the open data flow operations.

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#### 7.7.1 Satellite data downlink security aspects

#### 7.7.1.1 X-Band Satellite data downlink

The Sentinel-1/2/3/5P satellite payload data is downlinked without encryption in the X-Band.

Listening to Sentinel-1/2/3/5P satellite payload data requires an adequate X-Band antenna and acquisition system compliant with the satellite downlink specifications and link budget as well as the availability of regular up to date satellite orbital parameters and downlink planning.

As part of the CSC Ground Segment operation, the Sentinel-1/2/3/5P satellite payload data is acquired by a set of X-Band core Ground Stations, which receive regularly (typically daily) all necessary information to acquire the satellite data.

In addition, listening to the Senitnel-1 satellite payload data downlink is also possible for EC&ESA authorised entities (local X-Band stations) having signed a Collaborative agreement with ESA. These local stations are able to acquire Sentinel-1 data being observed and downlinked over the visibility cone of the local station as long as it overlaps (partially or completely) the coverage of a core station.

Data received at the X-Band ground stations (core or also local for Sentinel-1) is not encrypted and can be transformed into instrument data and higher-level user level data without the need for any decoding except for Sentinel-2.

Sentinel-2 payload data is compressed on board to reduce the data downlink volume. The acquired data shall be decompressed before it can be processed to higher user level data. Data decompression requires the use of a specific algorithm implemented in a software kit maintained by ESA as part of the CSC operations and provided to the CSC operational services implementing the Sentinel-2 data production as part of the CSC operations framework.

#### 7.7.1.2 S-Band Satellite data downlink

The Sentinel-1/2/3/5P satellite House-Keeping Telemetry (HKTM) is downlinked in S-Band without encryption.

Listening to Sentinel-1/2/3/5P HKTM data requires an adequate S-Band antenna and acquisition system compliant with the satellite downlink specifications and link budget as well as the availability of regular up to date satellite orbital parameters and downlink planning.

S-Band downlink information is made available only to S-Band stations providing the CSC S-Band acquisition service as part of the CSC operations framework.

#### 7.7.1.3 EDRS Satellite data downlink

Sentinel-1 and Sentinel-2 payload and HKTM data may be downlinked also through the EDRS Service. The optical communication between the Sentinel satellite and EDRS is not encrypted but the Ka-Band downlink from the EDRS to ground is encrypted as part of the EDRS data downlink.

Decoding of the satellite data is performed by the EDRS ka-Band receiving station before delivering the satellite data stream for production operations, i.e. the satellite data stream delivered by the acquisition station is not encrypted.

#### 7.7.2 CSC Data access and ground segment security aspects

The CSC Data access security covers all aspects associated to the management of the Sentinel data workflow as part of the CSC ground segment operations, from the data acquisition at the ground stations to the availability of the user level data for user access.

The CSC ground segment operations security management is based on the:

the ESA Security Directives;

The ESA Security Directives, endorsed by the ESA Security Committee, address security principles and the implementation standards of the ESA Security regulations to be applied through the Agency.

• the ESA EOP-G security framework.

For each operations project, the ESA Security Directives require establishing a System-Specific Security Requirement Statement (SSRS) for the enforcement of the ESA security policy and the production of the security operations procedures (SECOPS). EO has developed a specific Security Policy Framework, which is fully in line with the ESA Security Directives, and based on the ISO 27001 Information Security Management Systems (ISMS) standard.

The "Tailored" SSRS and SECOPS for Copernicus CSC GS Operations define the requirements necessary to mitigate the risks identified during a risk assessment campaign for the Operations of the CSC Ground Segment.

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The "Tailored" SSRS and SECOPS are applicable to all the CSC Ground Segment Services managed by ESA.

A regular EOF Security Risk Analysis is performed in order to regularly review the potential threads, vulnerabilities and necessary mitigation actions and update as necessary the Tailored "SSRS" applicable to all the CSC Ground Segment Services managed by ESA.

The approach for the CSC operations security is based on the distributed security ensured by each operational service provider, based on the specific Service Security Risk Analysis and in accordance with the "Tailored" SSRS defined by the EOF.

The EOF Project Specific Security Officer (PSSO) acts as a central EOF security reference for the EOF operations, maintaining the EOF Security Risk Analysis and the "Tailored" SSRS, managing the EOF security handling and the organisation of regular security audits of the EOF Operational Services.

The following principles apply for the security management of the CSC ground segment operations:

- "Tailored" SSRS and SECOPS are applicable to all the CSC Ground Segment Service Operation contracts put in place by ESA, including the Security Incident Management procedures.
- All requirements listed in "Tailored" SSRS" document are applicable to systems operated under ESA CSC Ground Segment Service Operation procurement.
- The System owner of an element of the CSC service performs a vulnerability assessment and system hardening for all the functions exposed to Internet and puts in place the necessary measures to preserve its operations in line with the outcome of the risk analysis, including an adequate set of security operating procedures complementing the SECOPS.

The compliance with the security procedures for each CSC Ground Segment operational service is verified by the EOF Project Specific Security Officer (PSSO) through security monitoring and auditing, allowing to verify the security level of the provided service, investigate complex and sophisticated security attacks and support security incidents and security breaches.

#### Data protection principles

The CSC Ground Segment relies widely on the use of commercial cloud service providers for the operations delivery. In order to ensure the Sentinels data protection, the following principles are followed:

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- The Sentinel data managed as part of the CSC ground Segment operations services is stored on servers located on the territory of the European Union or participating countries to the EU Copernicus programme;
- the CSC ground Segment operations service providers shall not be under any legal obligation from any country outside EU Member States or Copernicus participating countries to divulge without the consent of the EU and Copernicus participating countries any data or information managed/stored as part of the service.

#### Security related to data access

The CSC Ground Segment architecture relies on data delivery points to streamline the interfaces between different services and the overall data flow.

Access to these delivery points is restricted to the entities contributing to the CSC Ground Segment operations (e.g. LTA services, Production services, Data Access services, Cal/Val services) and requires previous ESA authorisation.

ESA intends to adopt a unified authorisation scheme in order to simplify the registration and management of associated security rules, maximising the use of available or planned European services. The different applications would therefore rely on a central service for identity management to avoid the multiplication of identity services that implicitly is considered as a risk.

# 8 COPERNICUS COLLABORATIVE GROUND SEGMENT & INTERNATIONAL PARTNERS

# 8.1 CSC Collaborative Ground Segment Partners

Close neighbours to the CSC Ground Segment are the complementary activities of the CSC Collaborative Ground Segment and those of the CSC International Partners. Both of these initiatives have been instrumental in the overall take-up of Copernicus and provide focal points for further exploitation and valorisation of the Copernicus Sentinel data.

The organisational concept for the Sentinel Collaborative Ground Segment has been established in the early phases of the CSC development. The concept was originally set out in the "Way forward for the

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establishment of the Sentinel Collaborative Ground Segment Agreements for the Sentinels' National Utilisation by ESA Participating States" (ESA/PB-EO(2013)19, rev.2). The concept foresees that a National Point of Contact is nominated by a State participating in the ESA CSC Programme (the "CSC Participating State") interested by this endeavour, and that this National Point of Contact will coordinate the Sentinel Collaborative Ground Segment activities for the corresponding CSC Participating State and thus act as an interface between ESA and the various initiatives taken at national level.

The collaboration is formalised through the signature of a formal agreement (understanding) based on the exchange of letters.

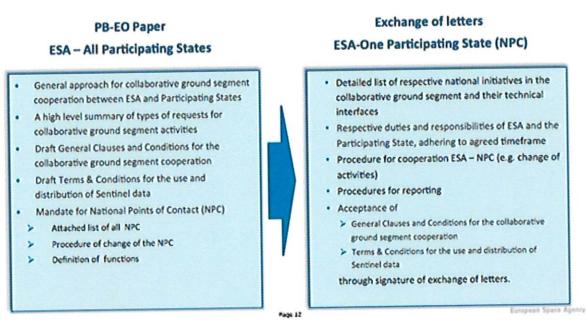


Figure 6. Establishment of the Copernicus Collaborative Ground Segment Agreements

The organisational concept is generalised to EU/ESA States not participating in the ESA CSC Programme, such that all Copernicus Contributing States may benefit from the support provided by ESA for their national initiatives. The interface to EU (non-ESA) member states and international cooperation partners is led by the European Commission in close coordination with ESA for technical aspects and the agreement formalised by EU/ESA jointly.

Two broad areas for cooperation with CSC Sentinel Collaborative Ground Segments have been largely developed:

Listening of Sentinel-1 Mission Data downlink and Production

- Collaborative Ground Segment Partner ground stations in overlap (partial or full) with the Sentinel-1 operational acquisition ground stations are able to listen real time data downlinks (pass-through) with the following potential activities.
  - (Near Real Time) data processing and distribution for Sentinel-1
  - Elaboration of (Near Real Time) Sentinel-1 products tailored to particular coverage/region, particular services, etc.
- Complementary Processing and Dissemination

Collaborative systems may offer product types or product formats in addition to those offered by the CSC core functions. Potential products of interest for collaboration may be:

- higher level products than produced by the core ground segment
- product/algorithms tailored to a particular coverage or region, services or user community
- generation of local/regional data sets with correction, projection, calibration, merging etc., different to the standardised data set offered by the GSC core ground segment.

Collaborative systems may also offer particular regional or thematic data access nodes and mechanisms, potentially including:

- o redistribution services of Sentinel products, systematically received from the core ground segment, becoming additional pick-up points (e.g. mirror sites)
- o regional online data servers and data pick-up points for specific user communities, etc..

ESA technical support to the Collaborative Ground Segment Partners is generally focused on the provision of technical interfaces to the partner initiatives. The technical interfaces for Collaborative Sentinels Mission Data Acquisition and Production entail principally the provision of information on the acquisition planning to enable the "listening in" to the Sentinel-1 real time downlinks (please refer to [RD-ADD] for more details), but also test data, documentation etc. to support for the data processing.

The technical interfaces for Collaborative Sentinel Data Product Dissemination and Access are primarily the privileged access to the Sentinel user level production via dedicated access interface (*collaborative data hub* - please refer to [RD-ADD] for more detail), but has also involved the collaboration through open source solutions to establish regional mirrors, and the operation of additional network of data relays for assisting with the bulk dissemination to the Collaborative Ground Segments.

The agreements established with the Collaborative Partners require a high-level reporting of the redissemination of the Sentinel Data by the national initiatives which are further collated by ESA for the European Commission.

#### 8.1 International Partners

As established in Article 9 of the Regulation establishing the Copernicus programme, the European Commission shall manage, on behalf of the European Union (EU) and in its field of competence, relationships with third countries and international organisations. Typically, a Memorandum of Understanding is concluded between the European Union and the third country or organisation. That document frames the general scope and conditions of the cooperation.

Following this, ESA is responsible to implement technical cooperation activities with the partner at no exchange of funds. To this end, ESA and the international partner agree on a common "technical operating arrangement". The paper defines respective roles and responsibilities, technical interfaces, timeframes and contact points on both sides.

ESA technical support to the International Partners is generally focused the privileged access to the Sentinel user level production via dedicated access interface (*international data access service* - please refer to [RD-ADD] and [RD-DSP] for more detail).

The agreements established with the International Partners require a high level reporting of the redissemination of the Sentinel Data by the international initiatives which are further collated by ESA for the European Commission. The agreements and may also cover other aspects dealing with reciprocity in Data Access.

# 9 OPERATIONS CONCEPTS FOR SENTINEL-1/2/3 C UNITS INTEGRATION

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Contrary to the expansion missions that imply new challenges and that will require to reach new level of performances, the integration of the C&D units is mainly an activity of configuration and complementary resources procurement.

The data flows are similar and the services put in place for the A&B generic. It is noted that the transition from the configuration with the A unit flying alone to a configuration with the B was organised without particular problems in the previous years.

The EOF will provide an increased flexibility. In the past, the procurement of the delta resources had to be planned far in advance and the risk of obsolescence in case of launch delays was important. The EOF will now work on a "just-in-time" approach in which resources are made available at the time they are needed and not just planned in advance for test period and put in hold for several months or years while waiting for launch.

It is noted that this approach is providing as well flexibility to adapt to the LTS final scenario proposing cost reduction whenever launch and operations are shifted, with the former approach procured HW is immediately creating cost even if the mission is not in operation.

Procurement of delta-services for acquisition, long term archive, production and data access will be planned as soon as the launch schedule will be finalised. Corresponding workorders or requests for service increased will be issued accordingly.

Some services would not require particular increase and would rely on additional configuration (e.g. coordination desk, traceability,,...). A special case is the reference system that is used to provide the necessary support for the pre-launch testing and verifications.

# 10 OPERATIONS CONCEPTS FOR THE OPERATIONAL INTEGRATION OF COPERNICUS EXPANSION AND NEXT GENERATION

The operations preparation of the future Copernicus Expansion and Next Generation missions will benefit from the existing operational framework to reduce development and integration effort.

The following logic is considered:

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- Development activities for mission specific elements planned to start between 4-2 years before launch: mission planning, operational data processors, calibration/validation and quality control elements
- Integration in operations planned to follow the modular and flexible service approach currently
  implemented for flying missions: dedicated service operations procurements for nominal tasks
  sized to the new mission requirements for acquisition, production, archiving & delta
  requirements on existing operational services to integrate the new missions (data access,
  operations coordination)
- Specific operations requirements and requirements for ground segment mission specific elements to be consolidated up to 2/3 years before launch (depending on mission complexity).

The approach is illustrated in the figure below:

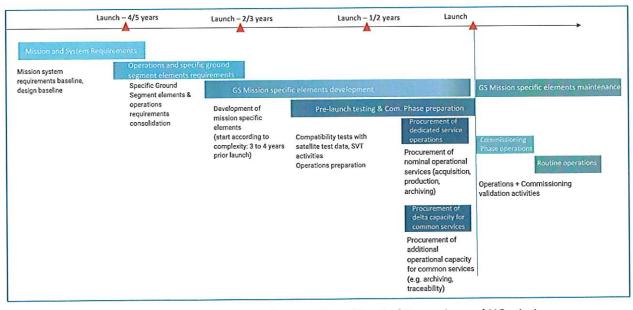


Figure 7: Concept for the operational integration of Sentinel Expansion and NG missions

The expansion missions are implying a major leap in terms of data production (foreseen around a factor 10 to 20 in terms of data volume). The current EOF is ready to cope with such an increase but complementary evolutions will be contemplated to achieve the level of performances and preserve the

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flexibility and the synergy with industry and user's operations. In particular, ESA is investigating the possibility to integrate European HPC resources into the production scenario and to better integrate user operations into the EOF. An increase by a factor 20 in the available data volumes would probably create many difficulties on the user side to exploit the data. The scenario is planned to be consolidated in the period 2023-2024.

Annex D. Legal notice on the use of Copernicus Sentinel Data and Service Information



# Legal notice on the use of Copernicus Sentinel Data and Service Information

The access and use of Copernicus Sentinel Data and Service Information is regulated under EU law. In particular, the law provides that users shall have a free, full and open access to Copernicus Sentinel Data and Service Information without any express or implied warranty, including as regards quality and suitability for any purpose.

EU law grants free access to Copernicus Sentinel Data and Service Information for the purpose of the following use in so far as it is lawful<sup>4</sup>:

- (a) reproduction;
- (b) distribution;
- (c) communication to the public;
- (d) adaptation, modification and combination with other data and information;
- (e) any combination of points (a) to (d).

EU law allows for specific limitations of access and use in the rare cases of security concerns, protection of third party rights or risk of service disruption.

By using Sentinel Data or Service Information the user acknowledges that these conditions are applicable to him/her and that the user renounces to any claims for damages against the European Union and the providers of the said Data and Information. The scope of this waiver encompasses any dispute, including contracts and torts claims, that might be filed in court, in arbitration or in any other form of dispute settlement.

Where the user communicates to the public or distributes Copernicus Sentinel Data and Service Information, he/she shall inform the recipients of the source of that Data and Information by using the following notice<sup>5</sup>:

- (1) 'Copernicus Sentinel data [Year]' for Sentinel data; and/or
- (2) 'Copernicus Service information [Year]' for Copernicus Service Information.

Where the Copernicus Sentinel Data and Service Information have been adapted or modified, the user shall provide the following notice:

<sup>&</sup>lt;sup>1</sup> Regulation (EU) No 377/2014 and Commission Delegated Regulation (EU) No 1159/2013.

<sup>&</sup>lt;sup>2</sup> In agreement with the Copernicus Sentinel Data Policy, ESA/PB-EO(2013)30, rev. 1.

<sup>&</sup>lt;sup>3</sup> See in particular Art. 3 and 9 of Regulation 1159/2013.

<sup>&</sup>lt;sup>4</sup> See in particular Art. 7 of Regulation 1159/2013

<sup>&</sup>lt;sup>5</sup> See in particular Art. 8 of Regulation 1159/2013.

- (1) 'Contains modified Copernicus Sentinel data [Year]' for Sentinel data; and/or
- (2) 'Contains modified Copernicus Service information [Year]' for Copernicus Service Information.

The users' rights on their personal data are protected under European law<sup>6</sup>. Such data will only be used by the European Commission and the providers of the said Data and Information for providing services to the user and for statistical as well as evaluation purposes.

<sup>&</sup>lt;sup>6</sup> Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data; Regulation (EC) No 45/2001 (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data.