ESA EO Operations Framework (EOF)

for the Copernicus Space Component

(EOF-CSC)

Operations Concept

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CHANGE LOG

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CHANGE RECORD

Issue 1	**Revision 1**		
Reason for change	Date	Pages	Paragraph(s)
Addressing comments from 2020 Checkpoint: TC-22, TC-23, TC-46, TC-48, TC-50, TC-88, TC-89, TC-90, TC-91, TC- 92, TC-93, TC-94, TC-95, TC-97, TC-98, TC-100, TC-101, TC-102, TC-103, TC-104, TC- 105 and additional updates from CSC GS Team	2022-09-27	Many	
Issue 1	**Revision 2**		
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Minor updates for Copernicus Checkpoint #2024	2024-03-22	Many	
Issue 1	**Revision 3**		
Reason for change	Date	Pages	
Minor updates	2025-06-12	Many	

Table of Contents

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 EU Member States 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.

The EOF-CSC is based on a service-based architecture and a clear set of operations management principles (management and architectural) hereafter referred as the ESA EO Framework (EOF) for the Copernicus Space Component.

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-CSC is documented throughout a complete package describing and specifying the applicable operational concepts as well as the architecture and operations procurement approach adopted for establishing and evolving the 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-CSC implementation is based on a 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 the transformation process which started in 2019, the EOF-CSC 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 EOF-CSC operations has been strengthened to enhance competitiveness, prevent industrial and technical lock-in and introduce the necessary operational flexibility and transparency to allow the adaptation 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 EOF 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 EOF-CSC operations baseline issued by ESA in the overall context of the Copernicus Programme documentation baseline as illustrated in the figure below:

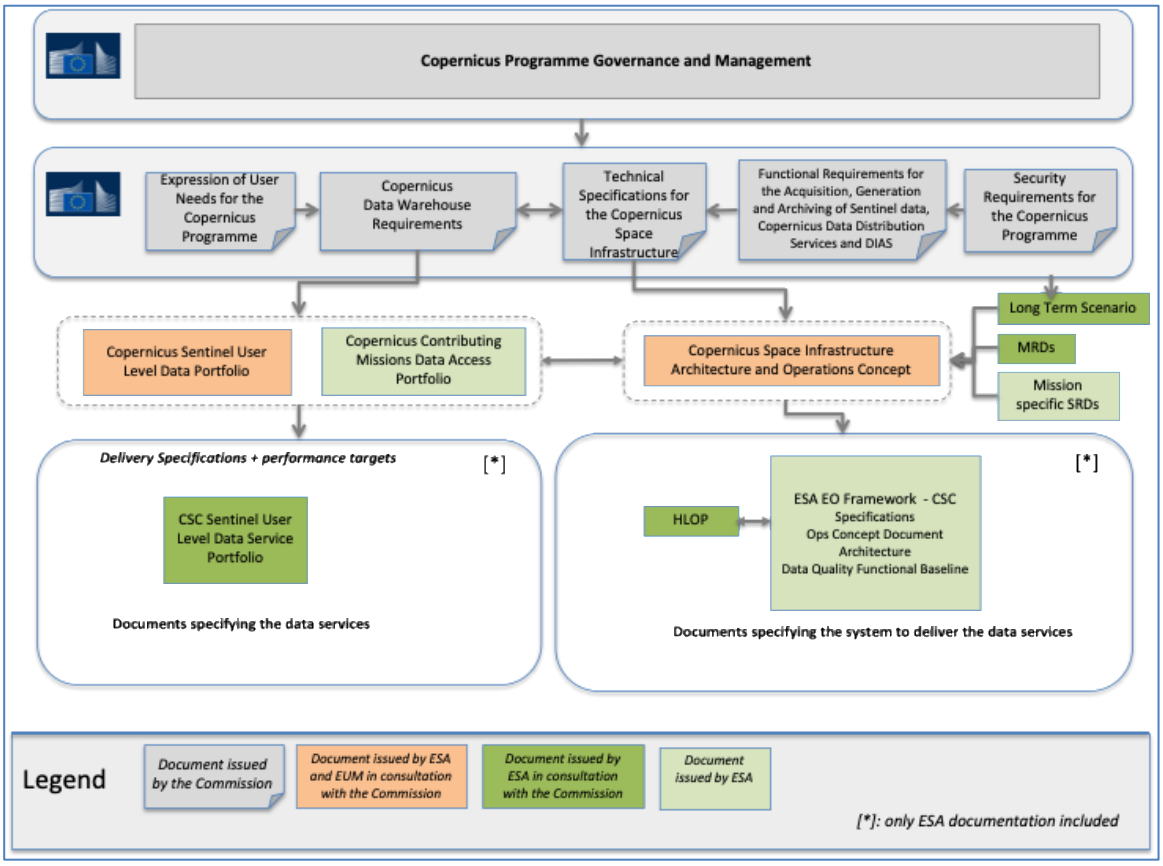

Figure 1: Copernicus operations documentation context

2.3 Applicable and Reference Documents

2.3.1 Applicable Documents

[AD-SPC] ESA EO Framework – CSC –Specifications [ESA-EOPG-EOPGC-RS-1]

2.3.2 Reference Documents

[RD-HLRM] ESA EO Operations Framework – CSC – High Level Roadmap [ESA-EOPG-EOPGC-PL-6]

[RD-IMP] CSC Operations - ESA Framework - Ground Segment Evolution Implementation Report [ESA-EOPG-EOPGC-PL-7]

[RD-STB] ESA EO Operations Framework – CSC - System Technical Budget [ESA-EOPG-EOPGC-TN-09]

[RD-OBS] ESA EO Operations Framework – CSC – Copernicus Missions Observation Strategy - Implementation [ESA-EOPG-EOPGC-TN-08]

[RD-MICD] ESA EO Operations Framework – CSC - 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] EOF-CSC Glossary [ESA-EOPG-EOPGC-TN-13]

[RD-ADD] ESA EO Framework – CSC – Architecture [ESA-EOPG-EOPGC-TN-7]

[RD-DSP] ESA EO Operations Framework – CSC – 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 Framework for the CSC Operations.

Section 2 provides the introduction and the scope of the ESA CSC 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 operational Framework.

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 EEOF-CSC 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, 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 2026 timeframe for CO2M and from 2028 onwards for the other Expansion 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:

- 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[1];
- 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;
- Sentinel-5P, in routine operations (at least until mid 2027).

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 EOF-CSC;
- The data calibration and validation and quality monitoring of the data generated by the EOF-CSC as well as the maintenance and evolution of the data processing algorithms and associated operational processing software.
- The free and open access to the Sentinel user level data and related services.

The operations of the future Copernicus expansion missions are expected to start in the 2027 time frame for CO2M and from 2028 for the other missions.

[1] For the case of Sentinel-1, a one-satellite-only routine operations have been managed with one satellite only since end 2021 (Sentinel-1B failure) until the completion of the Sentienl-1C in-orbit commissioning activities in May 2025.

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

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

- 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.

In order to cope with these anticipated challenges, the EOF-CSC has undergone a transformation process in the period 2020-2022 in close interaction with the Commission and Member States.

The evolved operations concept has allowed to increase the cost-efficiency with regards to the cumulative data 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 EOF-CSC concept relies on the following principles:

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

    - Establish the scope and boundaries of the EOF-CSC operational services to match as far as possible existing standard industrial services for cost efficiency through increased competition

    - Establish the operations procurement approach to ease the transfer of EOF-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 EOF-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 EOF-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 and optimizing the integration effort of new satellite units for on-going missions and the integration of future missions 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 EOF-CSC operations concept, the EOF-CSC has 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.

In light of these considerations, the EOF-CSC operations in the period 2024 to Q1 2028 will build upon the aforementioned principles, prioritizing resilience, flexibility, industrial competitiveness, and cost efficiency. This established framework will enable the initiation of a new transformation phase aimed at reducing the carbon footprint of EOF-CSC operations, aligning with the objectives of the European Green Deal, without compromising operational quality or cost-efficiency. Pursuing this goal will necessitate not only heightened efficiency but also the exploration of alternative scenarios, elevating awareness of carbon impact and its significance in the decision-making process for EOF-CSC operational management.

5 EOF-CSC 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 EOF-CSC end-to-end operations management and the management of the EOF-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.

- EOF-CSC 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 EOF-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:

- EOF-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 EOF-CSC operations services, depending on the service type (mission specific, transversal service, etc.). The EOF-CSC procurements and associated procurement approach is subject to the approval by the European Commission.

6 EOF-CSC COST MANAGEMENT

EOF-CSC 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-CSC 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.

The figures extracted from the ESA data access report 2023 are clearly demonstrating the constant increase of the Copernicus data volume to be managed through the years.

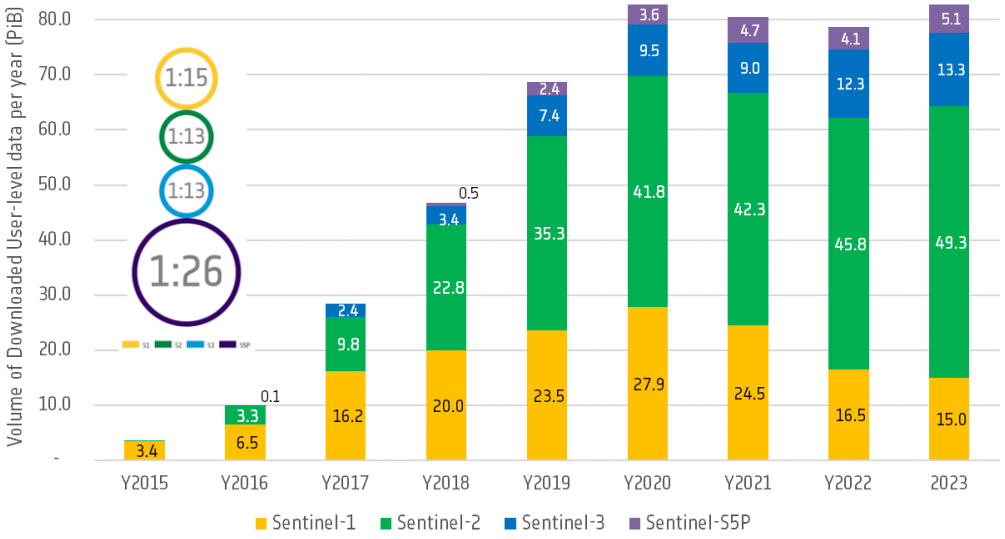

Figure 2: ESA EOF-CSC data dissemination ratio

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).

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 EOF-CSC operational capacity and performance should be configured accordingly.

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

- The data production: 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 can be sized precisely.

- The mission data preservation: 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 or archived, then the archiving resources for the long term preservation of the desired 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 depends on quality of service but also on 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 operational 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-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:

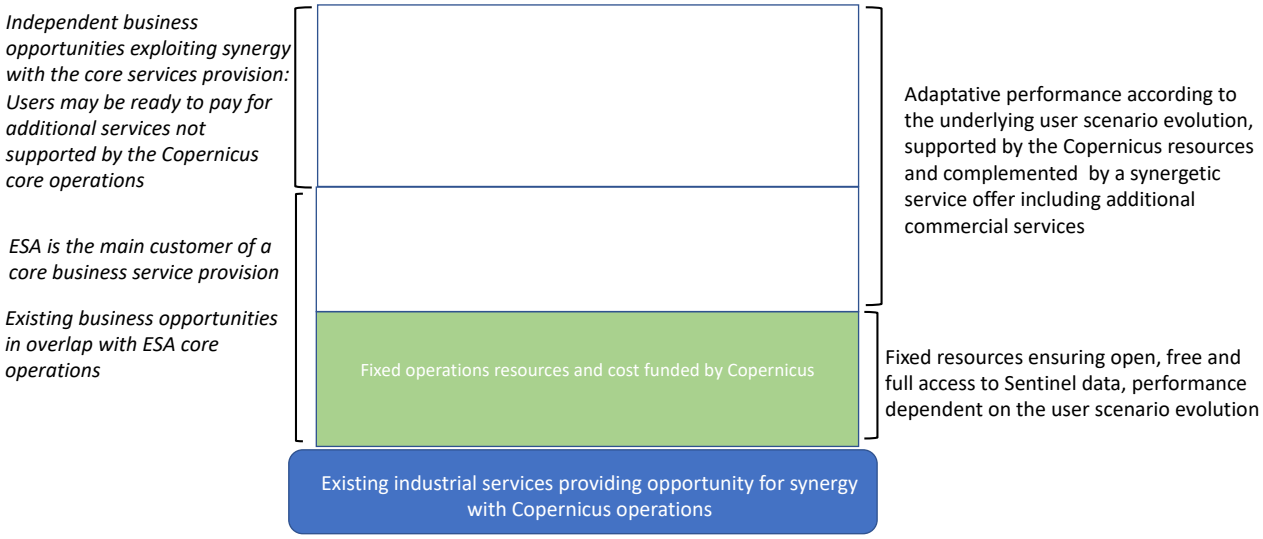

Figure 3: Fixed and variable resources

6.2 Budget control

According to the above, the EOF-CSC 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 EOF-CSC 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 operations and 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 since the implementation of the new model 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 in operational conditions of the service solutions 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…)
    - Any scenario is embedding variability and risks. The availability of a parametric cost model allows to transparently adapt the resources to the needs and the regular competitions ensure that operations benefit of the best market price and quality.

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.

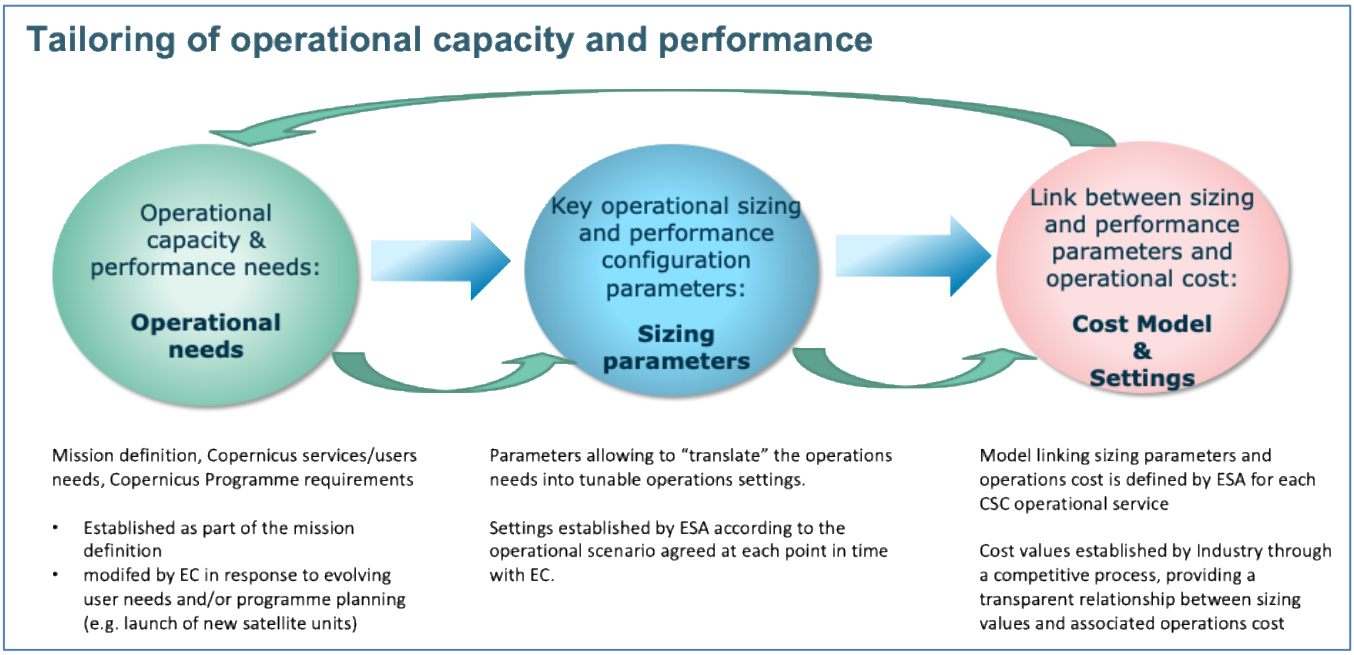

Figure 4: Cost model and operational sizing and performance

6.3 Synergy with complementary industrial services

The EOF-CSC 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.

ESA and the European Commission are engaged into the process of consolidating an approach allowing the opening of the EOF-CSC interfaces outside the scope of the core operations 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 EOF-CSC 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 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 EOF-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 EOF-CSC operations resources are established by the European Commission as part of the overall delegation process. The EOF-CSC is designed to be able to adapt the CSC operational 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-CSC strategy (in terms of design, procurement and implementation) allows tuning them without impacting the operations implementation.

The available EOF-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.).

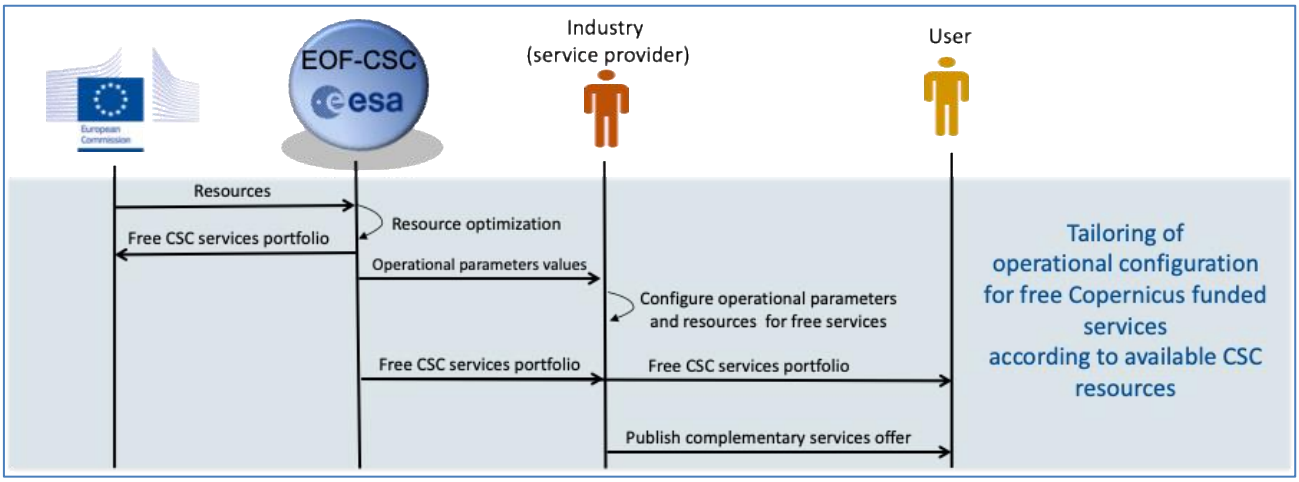

Figure 3. Adaptation of operations configuration for free and open services to the available CSC resources

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 data access service, some of the key parameters are related to the total volume of data available to users and to the exploitation ratio which is defined by the volume downloaded divided by the volume published and has gradually increased to values around 14. Published volumes may be considered known for a given observation and operations scenario, however the user scenario evolves with increasing user uptake.

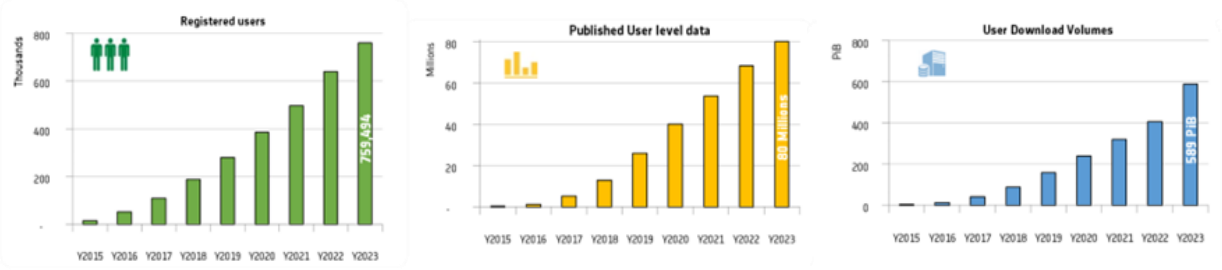

Figure 4. Evolution of the published data volumes and user scenario

As part of the cost management, 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 and availability of complementary services, including 3rd

party cloud services availability, and data organisation and access interfaces shall be optimised to reduce the need for data download and support the programme sustainability.

7 EOF-CSC OPERATIONS CONCEPT HIGHLIGHTS

7.1 EOF-CSC Sentinels Missions Users

In addition to the worldwide large public served on a best effort approach basis, which constitutes however in its entirety one of the most demanding user category in terms of resources, the EOF-CSC operations concept assumes that at least the following users typology will benefit from a dedicated configuration for the access to the Sentinel user level data through the CSC operations managed by ESA (detailed list of user typologies will be established and maintained with the European Commission as part of the CSC operations):

- Copernicus Services
- Union institutions and bodies
- 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 users typologies. The available interfaces, access rights and performance are described in the EOF 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 aims at requesting and retaining 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 EOF-CSC Data lifecycle

The EOF-CSC data lifecycle plays a central role in the management of the EOF-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 EOF-CSC 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 access 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.

    - In some cases, some of the information computed as part of the systematic processing of user level data may be archived for long term preservation to streamline potential future

data reprocessing (so called L0+) This refers typically to information expected to be unaltered by the availability of more accurate auxiliary information and which can be reused as input for a new data processing, allowing to streamline a second processing.

- Any potentially 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:
    - The same previously generated and 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 evicted and a new version is re-generated on the fly on user demand (typically for rolled-out user level products, data may be re-generated on demand as part of the Data Access service operations).
    - Rolled-out data remains available online but in a highly compressed form, supporting immediate access to all data for a number of use cases with minimum resources, with the additional possibility to re-generate the original uncompressed version on user demand (for lossy compression scenarios).
    - The data access performance for operations supported by Copernicus Programme may differ for rolled out data and for data available online, 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 Access Services Portfolio [RD-DSP].

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 foresees the data being maintained online for a suitable period. All reprocessed data are registered in traceability service. Reprocessing activities are reported within the end-to-end monitoring under the umbrella of the operations coordination.

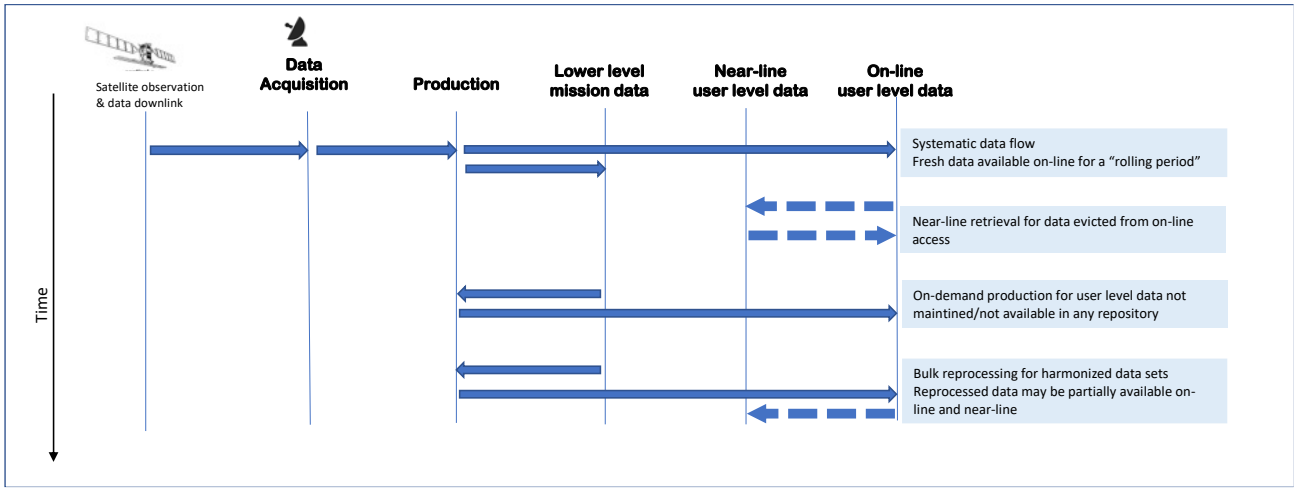

Figure 5. Data lifecycle illustration

7.2.1 EOF-CSC Data traceability

To provide an authoritative record of all user level data produced within the EOF-CSC, 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 EOF-CSC Complementary data access points

The EOF-CSC 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-CSC architecture is therefore streamlining the communication between operational services and supporting the possibility to offer complementary data access points all along the EOF-CSC 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 EOF-CSC 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 EOF-CSC 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 EOF-CSC Data Access Services

The Copernicus data access services 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.

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 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 progressively built some large datasets including sometimes 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 benefits 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 EOF-CSC architecture, the data access services have evolved in 2023 to towards an ecosystem of data sets, data access interfaces and processing services (the "Copernicus Data Space Ecosystem"), reducing the need for data download by 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 Copernicus Data Space Ecosystem 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 Copernicus Data Space Ecosystem is conceived as an element of a larger ecosystem, 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 synergy with new European initiatives like Destination Earth.

The Copernicus Data Space Ecosystem operations embed 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.

7.5 EOF-CSC Operational performance

The objective of the EOF-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 EOF-CSC operational performance provides a measure of the fulfilment of these objectives.

The EOF-CSC operational 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 performance measurement for each operational service contributing to the overall EOF-CSC 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 EOF-CSC mission operations (e.g. X-Band acquisition service KPIs are the same for Sentinel-1/2/3 data acquisition).

The EOF-CSC end-to-end operations performance monitoring service aims at providing an integrated view of the EOF-CSC managed operations at different levels (including at mission level and at service level) and through time. This requires accessing the outcome of the EOF-CSC 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 operational 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 services 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 services 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 services 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 services performance, providing an indication of how much the user level data meet the quality requirements, including the calibration and validation accuracy;

- Data Access services performance, as the visible iceberg of the EOF-CSC 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 operational 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 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.

Monitoring dashboard and performance

Each operational service contributing to the EOF-CSC operations, operates an interactive performance monitoring dashboard providing up to date measurements of the service KPIs and complementary performance parameters.

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

The EOF-CSC 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 EOF-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.

Operational performance benchmarking

As part of the EOF-CSC operations concept, ESA is independently measuring the competitiveness and performance of the EOF-CSC operational services and of the services offered to users.

The benchmarking of the services offered to users includes the EOF-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.

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 EOF-CSC Operations coordination

The EOF-CSC involves a large number of industrial services and elements, simultaneously contributing to the overall EOF-CSC operations in accordance with the service scope and performance.

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.

EOF-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 EOF-CSC security aspects

Security is an important aspect of the EOF-CSC operational management 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.

- EOF-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.

EOF-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 EOF-CSC and underlying security aspects;

- User data management.

The EOF-CSC operations security management concept is linked to the open and free Sentinels data access policy. As such, EOF-CSC 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 separated and dedicated data flow, subject to a completely different set of security measures and constrains.

7.7.1 Satellite data downlink security aspects

7.7.1.1 X-Band Satellite data downlink

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 EOF-CSC, the Sentinel-1/2/3/5P satellite payload data is acquired by a set of X-Band Acquisition Service operating a set of Ground Stations (hereafter referred as “core stations”), which receive regularly (typically daily) all necessary information to acquire the satellite data.

In addition, listening to the Sentinel-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.

7.7.1.2 S-Band Satellite data downlink

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 S-Band acquisition service as part of the EOF-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.

Decoding of the satellite data is performed by the EDRS ka-Band receiving station before delivering the satellite data stream for production operations.

7.7.2 CSC Data access security aspects

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

The EOF-CSC 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 EOF 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 EOF-CSC define the requirements necessary to mitigate the risks identified during a risk assessment campaign for the EOF-CSC .

The “Tailored” SSRS and SECOPS are applicable to all the EOF-CSC Services managed by ESA.

A regular 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 EOF-CSC Services managed by ESA.

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

The following principles apply for the security management of the EOF-CSC :

- “Tailored” SSRS and SECOPS are applicable to all the EOF-CSC 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 EOF-CSC Service Operation procurement.

- The System owner of an element of the EOF-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 EOF-CSC 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 EOF-CSC 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:

- The Sentinel data managed as part of the EOF-CSC operations services is stored on servers located on the territory of the European Union or participating countries to the EU Copernicus programme;

- the EOF-CSC 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 EOF-CSC 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 EOF-CSC 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 EOF-CSC Collaborative Ground Segment Partners

Close neighbours to the EOF-CSC 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 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.

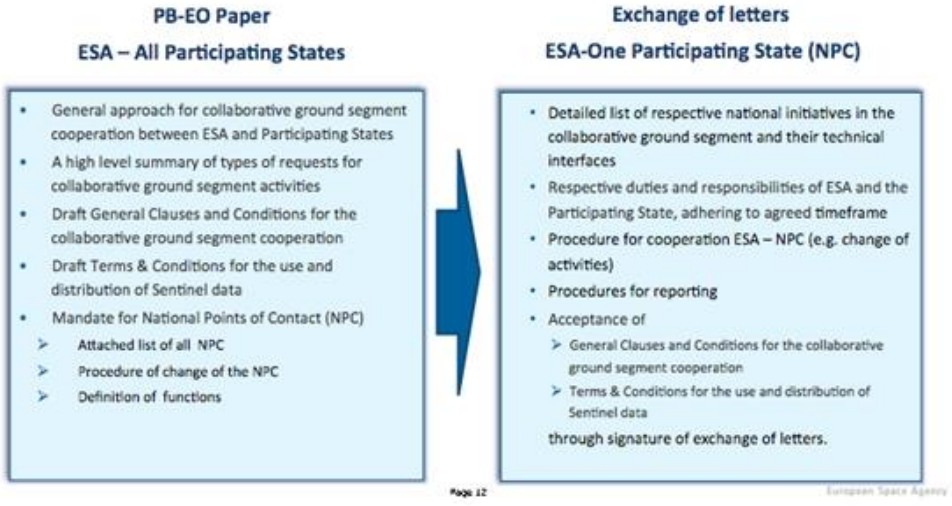

Figure 6. Establishment of the Copernicus Collaborative Ground Segment Agreements

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 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.
    - (Quasi Real Time) data processing and distribution for Sentinel-1
    - Elaboration of (Quasi 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 EOF-CSC core functions. Potential products of interest for collaboration may be:
    - higher level products than produced by the EOF-CSC
    - 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 EOF-CSC .

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

- redistribution services of Sentinel products, systematically received from the EOF-CSC, becoming additional pick-up points (e.g. mirror sites)

- 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 (please refer to [RD-DSP] 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 re-dissemination 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 (please refer to [RD-DSP] for more detail).

The agreements established with the International Partners require a high level reporting of the re-dissemination 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

Contrary to the Copernicus 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-CSC provides an great flexibility to onboard recurrent satellite units. 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-CSC works 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 CONCEPTS FOR THE OPERATIONAL INTEGRATION OF COPERNICUS EXPANSION AND NEXT GENERATION

The EOF-CSC 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:

- 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 EOF-CSC 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:

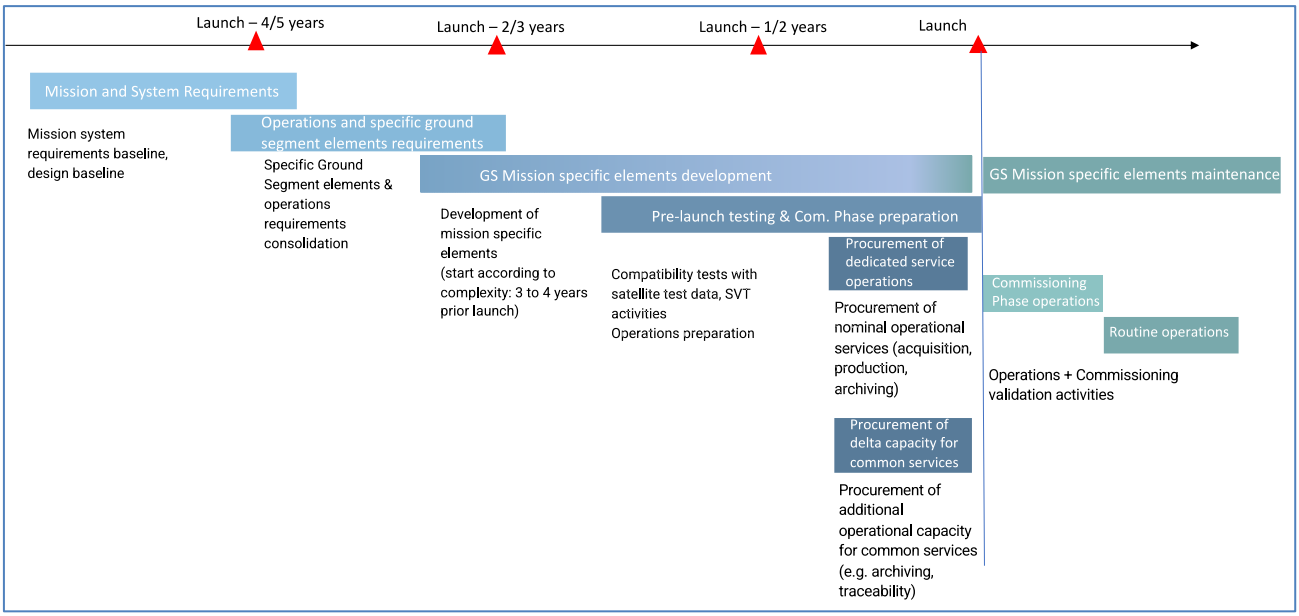

Figure 7: Concept for the operational onboarding of Sentinel Expansion and NG missions in the EOF-CSC

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 EOF-CSC is ready to cope with such an increase but complementary evolutions will be contemplated to achieve the level of performances and preserve the flexibility and the synergy with industry and user's operations. In particular, ESA is investigating the possibility to integrate HPC resources into the production scenario and to better integrate user operations into the EOF-CSC. 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 2025-2027.

11 ANNEX 1 PROCUREMENT APPROACH

11.1 EOF-CSC Operational Services Procurement Guidelines

The procurement of the EOF-CSC operations shall allow fulfilling the CSC technical and services requirements, match the associated architecture and support the establishment of a clear relationship between operations cost, capacity, performance and demand.

Accordingly, the guidelines outlines hereafter are followed for the implementation of the industrial procurements:

- Avoid industrial lock-in, neither technical or contractual
- Maximise industrial competition
- Support European industry development, innovation and competitiveness
- Maximise the usage of open source.
- Implement and maintain an open source solution for the Sentinel production and data access functions, available as ESA reference and as a candidate solution for potential future bidders for the production and/or data distribution services.
- Service implementation is under contractor responsibility (with few exceptions), operations shall comply with the service requirements in terms of interfaces, functional scope, performance and commitment. ESA reserves the right of auditing.
- In case of service provider change, the service implementation is not transferred between consecutive providers.
- Avoid provision of critical service operations by a single industrial provider, sharing the operational load between different service providers wherever technically possible and relevant.
- Reinforce the service approach and the industrial commitment.
- Minimize impact on overall operations performance in case of persistent underperformance of one service provider, allow for fallback solutions between the various providers of the same service.

- The award of a service provision to a given contractor shall not constitute an advantage in the competition for other services.

11.2 EOF-CSC Operational ServicesProcurement approach

The procurement of the EOF-CSC operations respect the guidelines defined above, with different procurement mechanisms foreseen to implement the procurement according to the nature of the service and the associated needs:

- Procurement through Open ITT, with one or more contracts awarded
- Procurement through the "2-step procurement procedure", with several Frame Contracts and subsequent Work Orders.

In addition, extension of existing services foreseen in specific cases through CCN and the need for Direct Negotiation may also be considered as necessary.

11.3 EOF-CSC Procurement – 2-steps procurement approach

This procurement approach is foreseen to maximise the competition and the value for money for the procured services, including the possibility for organising one or two competitions for the same service within the same MFF while minimising the overhead related to the procurement process. This approach may ease the transition of procured services between two MFFs.

The procurement approach presented hereto is an approach based on ESA Framework Agreement procurement procedure, as established at Article 15 of ESA Procurement Regulations, combined with an open pre-qualification period, in view to foster competition all along the concerned service duration.

The ESA Framework Agreement procedure is a two-step procurement approach, broken down as follows:

- Step 1 (Qualification Phase): Award of Frame Contracts between the Agency and several service providers further to a qualification process through Open Competition
- Step 2 (Implementation Phase): Award of Work Orders through Restricted Competitions between the Frame Contractors qualified under Step 1.

11.3.1 Step 1: Qualification Phase

In **Step 1**, the Agency releases Frame ITT(s) (as per Article 13.1. of ESA Procurement Regulations (ESA/REG/001, rev.3)) setting out the generic technical, managerial and contractual requirements for the required services (e.g. acquisition, LTA, production, etc.), with the objective to select service providers that demonstrate their capability and readiness to execute required services at the required performance levels.

The objective of Step 1 is to select Bidders that demonstrate their capability to implement activities for teh requested service and thus that qualify for the second step of the procurement.

The Step1 selection criteria for Bidders to qualify for participatign to the second step will be based on:

i. the Copernicus Eligibility requirements,

ii. Bidders' capacity to comply with the generic technical, managerial and contractual requirements (including generic Service Level Agreement) and

iii. if required the credibility of the costing offered.

In particular, economic operators will be asked to show evidence that the necessary infrastructures/facilities are in place at the time of the Frame ITT and can be maintained throughout the duration of the activity.

As a result of the evaluation of the "Qualification Tenders", the Agency will enter into Frame Contracts with each successful Bidder[2]. These Frame Contracts will be at zero costs, i.e. they will not contain any price, but will ensure the commitment of each Frame Contractors with the service generic requirements.

[2] According to Art. 15.1, A Framework Agreement is a single frame contract, or the aggregation of several Frame Contracts, the Agency has entered into with one or several contractors in order to ensure the delivery of supplies or rendering of services for a given period and/or within a given financial limit of liability and this following the methods foreseen under Articles 13 (Competitive tendering) or 14 (Non-competitive tendering) of ESA Proc. Regs.

In order to ensure the equality of treatment during the second phase of the Framework Agreement procedure, all Frame Contracts (including high level Service Level Agreement) will be awarded under identical terms and conditions.

Step 1 is based on standard open competition process established under Article 13 of ESA Procurement Regulations and under its Annex III - Part I (Tender Evaluation Board, TEB) and Part II (Procedure for Competitive Tendering), as amended by the FFPA/EU-ESA Contribution Agreement.

One of the characteristic of Step 1 lies in its Bidding Period, which will remain open for the whole Framework period. Interested Bidders will thus be entitled to submit their Qualification Tender at any time during the Bidding Period. Incoming Qualification Tenders will be evaluated by a so-called standing TEB, which will be convened on a regular basis.

11.3.2 Step 2: Implementation Phase

Under Step 2, ESA will organise restricted competitions (Request for Proposal – RFP) among the Frame Contractors, qualified under Step 1, for the procurement of specific services. These RFPs may cover selected service activities in scope of the Frame Contracts according to specific technical, managerial and contractual requirements for a limited period of activity. This second procurement step is referred to as "RFP" within this document.

The Agency will release a Request for Proposal (Annex III – Part IV of ESA Procurement Regulations (ESA/REG/001, rev. 3) setting out the specific technical, managerial and contractual requirements for the concerned services and period of activity. ONLY entities having signed a Frame Contract before the release of the Request for Proposal (RFP) and fulfilling the Copernicus Eligibility requirements will be eligible participate to the restricted competition.

The evaluation criteria to select the successful Frame Contractor are expected to be based on (i) the Frame Contractor's immediate operability and (ii) the Frame Contractor's Implementation Proposal price. In particular, Frame Contractors will be asked to confirm that the facilities and resources are still available and are operational.

As a result of the evaluation, the Agency will award one or more Work Orders to the Frame Contractor(s) that offer the most economic and effective employment of the Agency's resources, in combination with

the total weighted mark of the proposals and any other requirements established in the RFP. Depending on the operational needs of each RFP, the Agency reserves the right to select the most suitable combination of service providers fulfilling the operational needs.

Restricted competitions shall follow the procedure established under Article 15 of ESA Procurement Regulations and under its Annex III - Part I (Tender Evaluation Board) and Part IV (Procedure for Restricted Competitive Tendering in Framework Agreements) as amended by the by the FFPA/EU-ESA Contribution Agreement.

11.3.3 Complementary information

For the purpose of Annex III, the following precisions shall be considered:

- Publication of Frame Invitation to Tender: The intended ITTs (iITTs), and Frame ITTs under Step 1 are published on esa-star Publication and EC TED (Tenders Electronic Daily - European Union).
- Publication of RFPs: RFPs under Step 2 are published on esa-star Publication. If available sufficiently in advance, the intended RFPs (iRFPs) may also be published on esa-star Publication;
- Frame Contract awards are published on a yearly basis on ESA Copernicus web portal;
- Work Orders award are published on a yearly basis on ESA Copernicus web portal.
- CCNs to Frame Contracts may be considered as long as they are placed in such a manner as to ensure the equal treatment of all Frame Contractors under a Domain Framework Agreement.
- CCNs to WO may be considered as long as respect they do not impair the competition between Frame Contractors under the same Domain Framework Agreement.