COMMISSION IMPLEMENTING DECISION (EU) 2018/621

of 20 April 2018

on the technical specifications for the Copernicus space component pursuant to Regulation (EU) No 377/2014 of the European Parliament and of the Council

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EU) No 377/2014 of the European Parliament and of the Council of 3 April 2014 establishing the Copernicus Programme and repealing Regulation (EU) No 911/2010 ([1]), and in particular Article 9(8)(b) thereof,

Whereas:

(1) The Copernicus Programme, which was established by Regulation (EU) No 377/2014, is a civil, user driven programme, building on the existing national and European capacities, with the overarching operational objective to provide accurate and reliable information in the field of the environment and security, tailored to the needs of users and supporting other Union policies, more specifically relating to the internal market, transport, environment, energy, civil protection and civil security, cooperation with third countries and humanitarian aid.

(2) Pursuant to Regulation (EU) No 377/2014, Copernicus consists of three components, including a space component the purpose of which is to ensure sustainable space-borne observations for the following service areas: atmosphere monitoring, marine environment monitoring, land monitoring, climate change, emergency management and security. The Commission has the overall responsibility for Copernicus and coordinates its different components.

(3) The Technical specifications for the Copernicus Space component are necessary to establish a baseline for the implementation and evolution of the space component as part of the governance of Copernicus.

(4) The Technical specifications for the Copernicus space component should address aspects such as completion and operation of dedicated missions, reception, processing, archiving and dissemination of data, provision, archiving and dissemination of contributing mission data complementing dedicated mission data, and the process to ensure the evolution of the system.

(5) The development of the Copernicus Space Component started under the Global Monitoring for Environment and Security (GMES) Space Component Programme which includes funding from European Space Agency (ESA) and the Commission. The technical specifications for the Copernicus space component should cover the entire Space Component, with a specific focus on the activities funded under Regulation (EU) No 377/2014.

(6) The Copernicus Space Component as a whole is funded through multiple agreements. These include the agreements concluded under the ESA GMES Space Component Programme, the Copernicus Agreement, the Jason-CS and Jason-3 Optional Programme of European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). Activities funded under the ESA GMES Space Component Programme include the development of the Sentinel-1, -2, and -3 satellite *A* and *B* units, Sentinel-5p, Sentinel-4 *A* and *B* units and the Sentinel-5, -6 A units. Sentinel-6 is co-funded by EUMETSAT under the EUMETSAT optional Jason-CS programme.

(7) The measures provided for in this Decision are in accordance with the opinion of the Copernicus Committee,

HAS ADOPTED THIS DECISION:

Article 1

Technical specifications for the Copernicus space component

The technical specifications for the Copernicus space component referred to in Article 6 of Regulation (EU) No 377/2014, regarding its implementation and evolution on the basis of user requirements, as set out in the Annex, are hereby adopted.

([1]) OJ L 122, 24.4.2014, p. 44.

Article 2

Entry into force

This decision shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

Done at Brussels, 20 April 2018.

For the Commission
The President
Jean-Claude JUNCKER

ANNEX

1. SCOPE OF THE SPACE COMPONENT TECHNICAL SPECIFICATIONS

The Copernicus Space Component shall include the following activities:

(a) Development, Launch and Operations of dedicated Copernicus Satellites (Sentinels);

(b) Processing and generation of Sentinel Data Products based on the acquired data;

(c) Data Dissemination;

(d) Procurement and delivery of data from Third Party Satellite missions (Copernicus Contributing Missions), in case data requested by the Copernicus Services cannot be provided by the Sentinels.

The Satellite Data products shall be used by the Copernicus services and other users who, in combination with data from multiple sources, convert the data into uniform geophysical variables or higher level information products.

The Copernicus Space Component shall be designed following data and observation requirements from the Copernicus Core Users (Union institutions and bodies, European, national, regional or local authorities active in the domain of atmosphere monitoring, marine environment monitoring, land monitoring, climate change, emergency management and security). They shall form the basis for the definition of the Copernicus Space Component System Requirements.

The Copernicus requirements for space-based Earth Observation data covering the 2014-2020 period shall be documented in the **'Data Warehouse Requirements document' (version 2.*x*)**. It shall contain the requirements collected from Copernicus Services and Copernicus users requesting Earth Observation data. The updates of the document shall be taken into account for the evolution of the Copernicus Space Component. The data requirements are set out in Table 1.

Table 1

Summary table of the Copernicus Services Dataset requirements

Main Data requirement [1]	Potential Copernicus Data Sources
Land	
Pan-European (EEA39) High Resolution (HR) cloud free image coverage	Dedicated missions Contributing Missions
Full European Very High Resolution (VHR) coverage over Europe (EEA39)	Contributing Missions
Optical worldwide High Resolution coverage	Dedicated missions
Optical Medium Resolution worldwide coverage	Dedicated missions Contributing Missions
SAR Medium Resolution Worldwide coverage	Dedicated missions
SAR Low Resolution coverage	Contributing Missions
SAR Altimetry Medium Resolution Worldwide coverage	Dedicated missions
Marine	
Sea Ice Monitoring Medium Resolution SAR	Dedicated missions Contributing Missions

Main Data requirement (1)	Potential Copernicus Data Sources
Global/Regional Systematic Ocean Colour data	Dedicated missions Contributing Missions
Systematic Global and Regional sea surface temperature data	Dedicated missions Contributing Missions
Systematic Global and Regional Altimeter/Sea Level data	Dedicated missions Contributing Missions
Atmosphere	
Data for aerosol monitoring and forecasting	Dedicated missions Contributing Missions
Data for sulphur dioxide (SO_2) atmospheric composition monitoring and forecasting	Dedicated missions Contributing Missions
Data for formaldehyde (HCHO) atmospheric composition monitoring and forecasting	Dedicated missions Contributing Missions
Data for Ozone (O_3) atmospheric composition monitoring and forecasting	Dedicated missions Contributing Missions
Data for Carbon Monoxide (CO) atmospheric composition monitoring and forecasting	Dedicated missions Contributing Missions
Data for Carbon Dioxide (CO_2) atmospheric composition monitoring and forecasting	Dedicated missions Contributing Missions
Data for Methane (CH_4) atmospheric composition monitoring and forecasting	Dedicated missions Contributing Missions
Data for Nitrogen Dioxide (NO_2) atmospheric composition monitoring and forecasting	Dedicated missions Contributing Missions
Climate	
Data for deriving Essential Climate Variables (ECVs)	Dedicated missions Contributing Missions
Emergency	
Datasets with flexible specifications (rush mode, standard mode, high/very high resolution, optical/SAR, archive/new acquisitions)	Dedicated missions Contributing Missions

(1) The spatial resolution of Very High (VHR), High (HR), Medium 5MR) and Low Resolution (LR) images is defined as follows: VHR: <= 4 m; HR: > 4 m and <= 30 m; MR > 30 m and <= 300 m; LR > 300 m.

2. COPERNICUS SPACE COMPONENT OVERVIEW

2.1. **General**

The Copernicus Space Component (CSC) shall ensure an autonomous capacity of space borne observations to meet the objectives of the Copernicus programme, serving primarily the Copernicus Service Component. The Space Component shall consist of a *Space Segment* of Satellite missions and a *Ground Segment* to support these missions.

The *Space Segment* shall comprise two types of satellite missions, namely:

(1) Dedicated Satellite Missions, called the Sentinels, organised into six different 'families', which are: Sentinel-1, -2 and -3 (each 4 units, Full Operation Capacity consisting of 2 units flying simultaneously, replaced by 2 units to ensure continuity of observations), Sentinel- 4 (2 units), Sentinel-5 (3 units), and Sentinel-6 (2 units). Additionally Jason-3 and Sentinel-5p are developed by third parties but operated by Copernicus;

(2) Third Party Missions, consisting of Earth Observation satellites of European, national or commercial organisations, i.e. the **Copernicus Contributing Missions** (CCM).

The *Ground Segment* shall operate the Sentinel missions, receive data from the satellites, process, archive and distribute them to the Copernicus services and user communities, and generate a coordinated data stream to satisfy Copernicus data needs.

The Copernicus Space Component shall include the following activities:

(a) provision of space-borne observations from the dedicated missions. This includes the completion, maintenance, operation, validation and calibration of the Sentinels and related ground segment and data products and the protection of necessary frequency spectra;

(b) provision, archiving and dissemination of Contributing Mission data;

(c) preparatory activities related to the evolution of the Space Component in response to evolving needs, including the specification of new dedicated missions;

(d) protection of satellites against the risk of collision;

(e) safe decommissioning of the satellites at the end of life.

2.2. **Copernicus space component financing**

Activities funded under Regulation (EU) No 377/2014 shall include the operations of all Sentinels and Jason-3, procurement of the Sentinel-1, -2, -3 C and D units, procurement of Sentinel-5 B and C units, procurement of the Sentinel-6B unit, Launch Services, Data dissemination and the procurement of Contributing Mission data.

Activities funded under the Copernicus Agreement shall be closely interlinked with the activities funded by the ESA GMES Space Component Programme and the EUMETSAT Jason-3, -CS Optional programmes.

2.3. **Governance and implementation**

The implementation of most Copernicus Space Component activities shall be delegated to ESA and EUMETSAT.

The activities delegated to ESA shall include the overall technical coordination of the space component and the definition of the overall architecture of the space component. ESA shall be entrusted with the following tasks:

(a) procurement and Development of the recurrent C and D units of Sentinel-1, -2, and -3 satellites;

(b) procurement of the B and C units of the Sentinel-5 instrument;

(c) procurement of the Sentinel-6B unit;

(d) procurement of launch services and launch preparation (including activities from Flight Acceptance Review to In Orbit Commissioning Review);

(e) operations of the Copernicus Space Component specified in section 3.5;

(f) data circulation and network services operations;

(g) dissemination of Sentinel-1, -2, -3 (partim land), and Sentinel-5p data, as well as Data and Information Access Services;

(h) data Access Procurement from Copernicus Contributing Missions;

(i) maintenance of relevant Copernicus Space Component elements;

(j) evolution of relevant Space Component Elements;

(k) support to the Commission in establishing user requirements, service specifications and service data requirements for the space infrastructure.

The activities delegated to EUMETSAT shall include the operation of dedicated missions and ensuring access to contributing mission data in line with its mandate and expertise. EUMETSAT shall be entrusted with the following tasks:

(a) operations and maintenance of the Sentinel-3 satellite series in coordination with ESA;

(b) operations and maintenance of the Sentinel-4 and Sentinel-5 instruments included on the MTG and METOP-SG satellites;

(c) operations and maintenance of the Jason-3 satellite based on the cooperation with partner organisations;

(d) operation and maintenance of the Sentinel-6 mission in coordination with ESA and other partner organisations;

(e) provision of the ground segment, data access operations and data dissemination for Jason-3, Sentinel-3 (partim marine), -4, -5, and -6, as well as Data and Information Access Services;

(f) maintenance and evolution of the ground segment and infrastructure;

(g) provision of relevant data from selected contributing missions related to marine, atmosphere and climate change services;

(h) support to ESA for the development, launch and early Orbit phase of the C and D units of Sentinel-3 and the B unit of Sentinel-6;

(i) support to ESA for the development of the B and C units of Sentinel-5;

(j) support to the Commission in establishing user requirements, service specifications and service data requirements (upon request and subject to additional funding by the Commission);

(k) support to the Copernicus climate change monitoring service, reprocessing of EUMETSAT and agreed Copernicus and third party data (upon request and subject to additional funding by the Commission).

The management of these activities shall include the day-to-day operational interactions with the relevant services providers and users, the management of risks, the communication activities and support to the Commission in its interactions with Copernicus Stakeholders.

Coordination between ESA and EUMETSAT shall be managed through a Joint Operations Management Plan (JOMP).

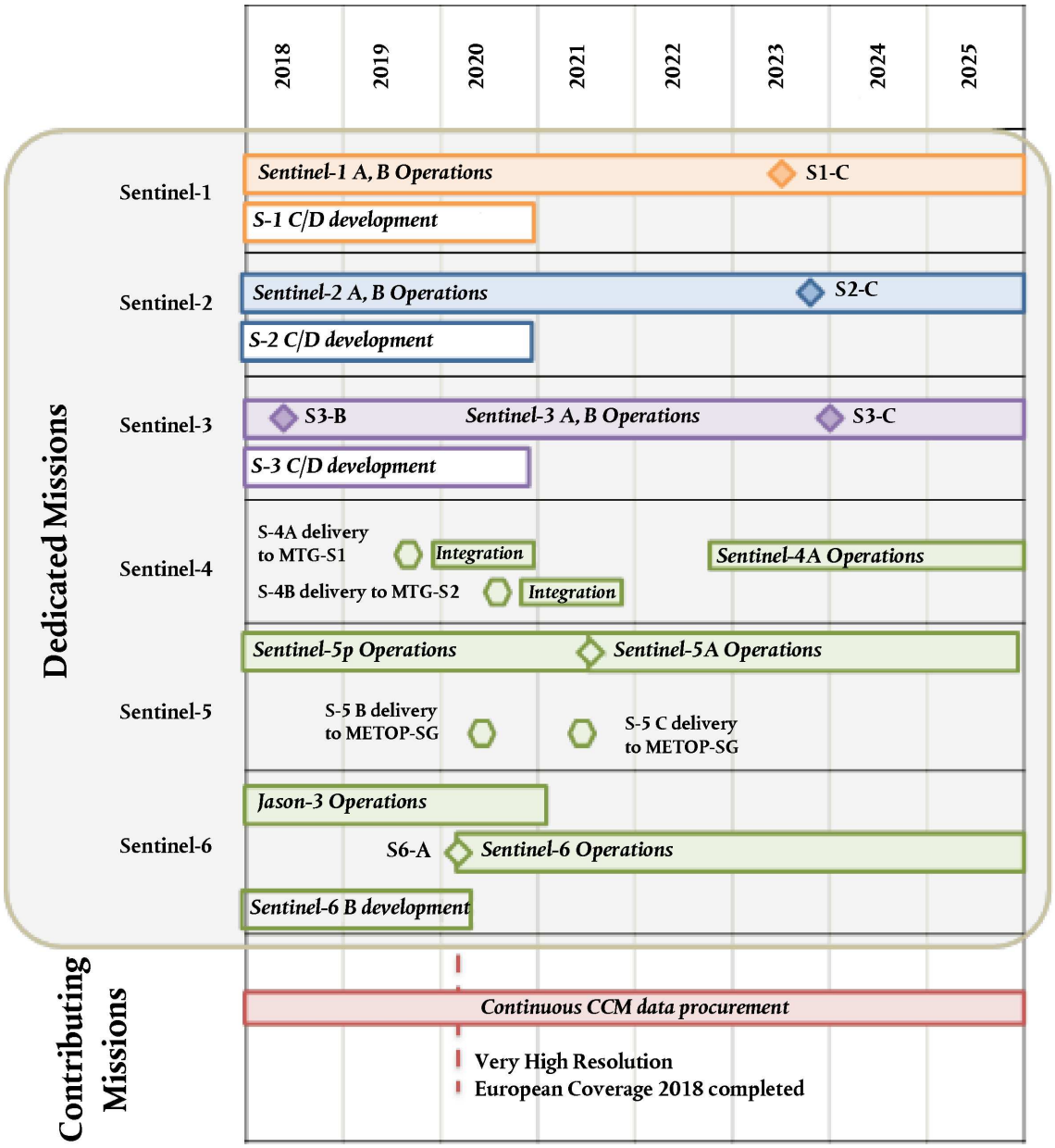
2.4. **Indicative Deployment Schedule**

The CSC Space segment activities and tasks with relevance to the MFF (2014-2020) funding shall be implemented in a multi-annual perspective, in particular the procurement programme of the recurrent units.

The major milestones for the CSC component shall include the milestones and accomplishments as depicted in the following figure.

Figure 1

Indicative schedule for the Copernicus Space component activities



The schedule shall be updated following the technical implementation of activities and evaluation of programmatic options.

2.5. **Copernicus Data and Information Policy**

The use of the data shall be subject to a legal notice which shall indicate that:

(a) users 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;

(b) Union 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:

(1) reproduction;

(2) distribution;

(3) communication to the public;

(4) adaptation, modification and combination with other data and information;

(5) any combination of points (1) to (4).

(c) by using Sentinel Data or Service Information the user shall acknowledge that these conditions are applicable to him/her and that the user renounces to any claims for damages against the Union and the providers of that data and information.

2.6. **Standards**

The spatial data products and information generated within the Copernicus space component activities shall be compatible and interoperable with the data and spatial information systems provided by Member States in accordance with Directive 2007/2/EC of the European Parliament and of the Council ([1]) and Commission Regulations (EC) No 1205/2008 ([2]), (EU) No 1089/2010 ([3]) and (EC) No 976/2009 ([4]).

2.7. **Monitoring and Evaluation**

Implementation of the CSC activities shall be monitored by the Commission. Both ESA and EUMETSAT shall report on the progress of the implementation of the activities entrusted to them on a quarterly basis. The Commission shall process the reports and shall request clarifications in case needed. The quarterly reports shall contain, amongst others, Key Performance Indicators (KPIs) which shall be used to monitor the implementation of the Copernicus Space Component. KPIs shall include:

(a) number of Sentinel Missions and number of flying Sentinel units;

(b) number of missions having reached full operational capacity (2 units flying simultaneously in the case of Sentinel1, -2, and -3);

(c) number of recurrent units under development;

(d) availability of Sentinel units and instruments;

(e) volume of data distributed to users;

(f) number of users;

(g) end-to-end availability and continuity of the Sentinel Data Access Service;

(h) end-to-end availability of Contributing Mission Data Access Service;

(i) data Access volume from Copernicus Contributing Missions;

(j) licenses signed regarding Copernicus Contributing Missions;

(k) timeliness of Data delivery;

(l) user support and help desk performance.

KPIs shall be reported by both EUMETSAT and ESA in accordance with their entrusted activities.

Apart from the operational monitoring of the performance of the Space Component, the achievement of the objectives of all the tasks financed by Copernicus at the level of their results and impacts, their European added value and on the efficiency of the use of resources shall be evaluated. This evaluation shall be conducted in close cooperation with the Copernicus operators (ESA and EUMETSAT for the Space Component) and the Copernicus users.

3. DEDICATED COPERNICUS MISSIONS (SENTINELS)

3.1. **General**

The dedicated missions shall consist of a space segment and a ground segment, each with its own functions and characteristics. The *space segment* shall include the satellite and/or instrument and the *ground segment* shall include all infrastructure located on the earth, including receiving stations, processing centres, flight operations segments and mission performance centres.

([1]) Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) (OJ L 108, 25.4.2007, p. 1).

([2]) Commission Regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata (OJ L 326, 4.12.2008, p. 12).

([3]) Commission Regulation (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services (OJ L 323, 8.12.2010, p. 11).

([4]) Commission Regulation (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the Network Services (OJ L 274, 20.10.2009, p. 9).

The ground segment assets under control of ESA shall be provided as a service. Operations of both the space and ground segment shall be Copernicus funded.

A detailed description of all technical elements of the Copernicus Space component shall be made publicly available.

3.2. **Space Segment – Sentinel missions**

3.2.1. *Space Segment general description*

The dedicated Sentinel missions shall carry a range of technologies, including radar and multispectral imaging instruments for land, ocean and atmospheric monitoring. They shall be developed by ESA and organised into six different mission families.

Sentinel-1 mission: shall comprise a constellation of at least two polar-orbiting satellites to reach Full Operational Capacity (FOC), operating day and night performing C-band synthetic aperture radar imaging, enabling them to acquire imagery regardless of the weather;

Sentinel-2 mission: shall comprise a constellation of at least two two polar-orbiting satellites aiming to monitor variability in land surface conditions supporting the monitoring of changes to vegetation within the growing season;

Sentinel-3 mission: shall comprise a constellation of at least two polar-orbiting satellites with the objective to monitor oceans and land masses globally. Sentinel-3 *partim marine* shall measure sea surface topography, sea surface temperature, and ocean surface colour to support ocean forecasting systems, environmental monitoring and climate monitoring. Sentinel-3 *partim land* shall measure land and inland water surface height, land surface temperature and land surface colour;

Sentinel-4 mission: Sentinel-4 shall monitor key air quality trace gases and aerosols over Europe in support of the Copernicus Atmosphere Monitoring Service (CAMS) at high spatial resolution and with a fast revisit time. Sentinel-4 shall be implemented as part of the Geostationary EUMETSAT Meteosat Third Generation Satellite System. The Sentinel-4 instruments shall be hosted on the EUMETSAT satellites MTG-S-1 (Sentinel-4A) and MTG-S-2 (Sentinel-4B), with an expected 15,5 years of operations for both satellites combined;

Sentinel-5 mission: Sentinel-5 shall provide accurate measurements of key atmospheric constituents such as ozone, nitrogen dioxide, sulphur dioxide, carbon monoxide, methane, formaldehyde, and aerosol properties. Sentinel-5 shall be implemented as part of the EUMETSAT Polar System of Second Generation (EPS-SG). The Sentinel-5 instruments shall be hosted on the EUMETSAT satellites METOP-SG-A-1, METOP-SG-A-2, METOP-SG-A-3 (each with a design lifetime of 7,5 years and hosting Sentinel-5A, -5B, -5C respectively). Sentinel-5p ([1]) shall be the precursor mission to Sentinel-5;

Sentinel-6 mission: shall be a radar altimeter mission, with the objective of providing high-precision measurements of global sea-level as a reference altimetry mission. Sentinel-6 shall consist of 2 units (A and B, each with a design lifetime of 5 years) covering 10 years of observations.

Sentinel-1, Sentinel-2 and Sentinel-3 shall consist each of 4 satellites, whereby 2 units are needed to reach Full Operational Capacity (FOC) and 2 units shall ensure recurrent observation capacity after the end-of-life of the first 2 units.

The operations of **Jason-3** ([2]) shall be included in the Copernicus Space Component to provide continuity of observations between Jason-2 and Sentinel-6 as a reference altimetry mission.

The characteristics of the Copernicus dedicated missions shall be as specified in Table 2.

([1]) The Sentinel-5 Precursor (Sentinel-5p) mission is a joint initiative between ESA and the Kingdom of the Netherlands.

([2]) Jason-3 is the result from the long-standing cooperation between EUMETSAT, NOAA, CNES and NASA. It is a High Precision Ocean Altimetry Mission that provides continuity between Jason-2 and Sentinel-6 and is operational since 2016 with an envisaged lifetime of 5 years.

Table 2

Copernicus Dedicated missions characteristics

Sentinel Mission	Main Characteristic and purpose	Number of Units	Payloads	Satellite orbit	Approximate Period of operations (1)
Sentinel-1	RADAR Mission	4 units (A, B, C, D), two units are flying in parallel for full capacity	C-Band SAR Payload with centre frequency of 5,405 GHz (4 polarisations) and 4 modes: — Strip Map mode with 80 km Swath and 5 × 5 metre spatial resolution — Interferometric Wide Swath Mode with 250 km swath and 5 × 20 metre spatial resolution — Extra-wide Swath Mode with 400 km swath and 20 × 40 m spatial resolution — Wave mode with 5 × 5 metre spatial resolution at 100 km along the orbit	Sun-Synchronous orbit at approximately 693 km	A, B: 2014 – 2022 C, D: 2022-2030
Sentinel-2	High Resolution optical mission for land imaging	4 units (A, B, C, D), two units are flying in parallel for full capacity	— MSI — Multi Spectral Imager with 13 multispectral channels between 400 nm and 2 300 nm, spectral resolution between 1 nm and 180 nm and spatial resolutions of 10 m, 20 m and 60 m. Includes an Optical Communication Payload for mission data relay through EDRS.	Sun-Synchronous orbit at approximately 786 km	A, B: 2015 – 2023 C, D: 2023-2030
Sentinel-3	Global Ocean and Land Imaging	4 units (A, B, C, D), two units are flying in parallel for full capacity	— OLCI – Ocean and Land Colour Instrument with 21 bands and spatial resolution of 300 m — SLSTR – Sea and Land Surface Temperature Radiometer with 9 bands and spatial resolution of 500 m (VIS, SWIR) and 1 km (MWIR, TIR) (2) — SRAL – SAR Radar Altimeter with dual CX and Ku bands — MWR – Microwave Radiometer, with an operation frequency in dual 23,8 GHz and 36,5 GHz	Sun-Synchronous orbit at approximately 814,5 km	A, B: 2016 – 2023 C, D: 2023-2030

Sentinel Mission	Main Characteristic and purpose	Number of Units	Payloads	Satellite orbit	Approximate Period of operations (1)
Sentinel-4	Atmospheric monitoring	2 instruments (A, B), on board consecutive Meteosat Third Generation – Sounder satellites	The Sentinel-4 instrument is a high-resolution imaging spectrometer (spatial resolution of 8 × 8 km) covering three wavelength bands: — Ultraviolet (305-400 nm) — Visible (400-500 nm) — Near-Infrared (750-775 nm)	On board Meteosat Third Generation Satellites in geostationary orbit at approximately 35 786 km. Coverage of Europe and North Africa with a repeat cycle of about 60 minutes	2022 - 2040
Sentinel-5	Atmospheric monitoring	3 units (A, B, C), on board consecutive METOP Second Generation – A satellites	The Sentinel-5 UVNS instrument is a high resolution spectrometer (spatial resolution about 7 km), covering the following wavelength bands: — Ultraviolet (270-370 nm) — Visible (370-500 nm) — Near-infrared (685-773 nm) — Short-wave infrared (1 590-1 675; 2 305-2 385 nm)	Part of the EUMETSAT Polar System of Second Generation (EPS-SG) at approximately 817 km	2022-2040
Sentinel-5p	Atmospheric monitoring	Precursor satellite for Sentinel-5	— TROPOMI — TROPOspheric Monitoring Instrument with 4 channels in the following spectral ranges: 270-500 nm, 675-775 nm, 2 305-2 385 nm and spatial resolution of 7 × 7 km	Sun-Synchronous orbit at approximately 824 km	2017 - 2024
Sentinel-6	High Precision Ocean Altimetry	2 units (A, B)	— POSEIDON-4 – SAR Radar Altimeter — AMRC-C – Climate-quality microwave radiometer, a NOAA/JPL contribution	Non-Sun-synchronous at approximately 1 336 km	A: 2020 – 2025 B: 2025 - 2030

(1) The period of operations may change depending upon the actual life time of the individual satellite units and evaluation of programmatic options.
(2) Abbreviations: VIS = Visual Range Bands; SWIR = Short Wave Infrared; MWIR = Mid-Wave Infrared; TIR = Thermal Infrared.

3.2.2. *Space Segment activities*

ESA shall be responsible for the procurement and launch of the following satellites and instruments:

(a) development of the C and D units of Sentinel-1, -2, and -3;

(b) sentinel-5B and -5C instruments;

(c) sentinel-6B unit;

(d) launch Services.

Development and Procurement of the Sentinel-1, -2, -3 C/D units

ESA shall be responsible for the procurement, development and Flight Acceptance Review of the Sentinel-1, -2, -3 C and D units. In addition, the launch preparation activities of the –C units shall be covered by Copernicus, in case they occur before 31 December 2021.

The C and D units shall be procured with equivalent technical specifications as the A and B units to ensure technical and operational consistency. However, the development of the A, B and C, D units shall take into account hardware obsolescence due to the time difference with the development of the A and B units. The Sentinel-1 C and D units should be equipped with an Automatic Identification System (AIS) instrument to augment the SAR payload data for ship marine traffic applications and all C and D units shall be equipped with GNSS receivers. The Sentinel-1 and -2 C and D units shall include an Optical Communication Payload and the Sentinel-3 C and D units shall include a DORIS payload, all procured as part of the contract and financed within Copernicus.

Development and procurement of the Sentinel-5B and -5C instruments

ESA shall be responsible for the procurement, development and support of the integration onto METOP-SG of Sentinel-5B and -5C, including the verification of the end-to-end instrument performance.

Development and procurement of the Sentinel-6B unit

Sentinel-6B shall be a fully recurrent unit of Sentinel-6A. Sentinel-6B shall be included as an option in the development contract of Sentinel-6A.

Launch services

Launch services for the Sentinel-1, -2 and -3 A and B units that have started under the ESA GMES Space Component Agreement shall be continued under Copernicus. As part of Copernicus ESA shall assume full responsibility for the procurement of the launch services of Sentinel-1B, -2A and -3B. The procurement of launch services shall include the launcher manufacturing, spacecraft adaptor, launch campaign support, launcher/satellite interface engineering and all activities from Flight Acceptance Review up to the end of the In-Orbit Commissioning Review (including Launch and Early Orbit Phase).

3.3. **Ground Segment – Sentinel missions**

3.3.1. *General description*

The Sentinel Ground Segment shall provide the primary access to Sentinel missions. The primary components of the Sentinel ground segments shall be the following:

(a) sentinel Flight Operations Segment (FOS);

(b) sentinel Payload Data Ground Segment (PDGS).

The Sentinel PDGS operations shall rely on a Wide Area Network (WAN) and Data Access Services.

3.3.2. *Flight Operations Segment*

The Flight Operations Segment (FOS) shall provide the capability to schedule the mission operations and to monitor and control the spacecraft and payload during all mission phases. The FOS shall be responsible for spacecraft commanding activities and acquisition of S-band telemetry. It shall provide the functionality required for the generation and the uplink of the routine platform and instrument command schedules and the systematic archiving/analysis of the acquired housekeeping telemetry. The FOS shall include a Flight Dynamics System Facility, allowing orbit determination and prediction, as well as generation of attitude and orbit control information.

FOS functions and activities shall include the scheduling of S-band ground station visibility segments and access to archived housekeeping telemetry to authorised external users. Besides performing these routine tasks, the FOS Mission Control Team shall be responsible for monitoring the satellite's health status and implementing all necessary recovery actions in case of anomalies, and verification and uplink of on-board software patches.

The FOS debris collision avoidance service shall calculate the probability of a collision of any Sentinel satellites with other satellites and/or debris and provides corresponding collision avoidance forecast reports. These shall be analysed and translated in satellite collision avoidance manoeuvres when appropriate.

The FOS shall support safe and reliable spacecraft end-of life measures, including re-entry and disposal activities.

3.3.3. *Payload Data Ground Segment*

The Payload Data Ground Segment shall include the following components:

(a) sentinel Core Ground Stations (CGS);

(b) sentinel Processing and Archiving Centres (PACs);

(c) sentinel Mission Performance Centres (MPC);

(d) sentinel Payload Data Management Centres (PDMC);

(e) sentinel Precise Orbit Determination Service (POD).

Sentinel Core Ground Stations (CGS)

ESA shall manage the overall network of X-band Core Ground Stations. A dedicated infrastructure shall allow to do the following:

(a) acquire Sentinel Data Downlinks;

(b) demodulate and Store the Instrument Source Packets (ISP) data;

(c) provide ISP to the Level-0 processor and to EUMETSAT for Sentinel-3;

(d) send the L0 data to the Processing and Archiving Centres;

(e) perform Near Real Time L1/L2 production and make the data available to users and the PACs.

Sentinel Processing and Archiving Centres (PACs)

The Processing and Archiving Centres shall ensure the archiving of the Sentinel data, the systematic non-time critical and/or on-the-fly data processing, the online access to the products and the dissemination of the data to other CSC elements.

Sentinel Mission Performance Centres (MPC)

Calibration and validation activities for Sentinel-1, -2, -3 and -5p shall be performed by Mission Performance Centres. The activities shall include, amongst others, the maintenance and evolutions of algorithms, the operational quality control and the end-to-end system performance monitoring. The MPC shall rely on the provision of complementary quality services from the Expert Support Laboratories and from dedicated CAL/VAL groups to maintain the required mission quality performances.

Sentinel Payload Data Management Centres (PDMC)

The Sentinel Payload Data Management Centre (PDMC) shall provide the interface with the FOS for the satellite tasking and the downlink planning. The PDMCs are responsible for the Sentinel mission and systematic production planning, in line with the Data Access and Mission requirements and the PDGS configuration including production organisation, circulation and the dissemination setup.

Sentinel Precise Orbit Determination Service (POD)

The Sentinel POD service shall provide precise orbit data to support the PDGS non- real time processing. The POD centre shall be common to the Sentinel-1, -2 and -3 missions. It shall receive GPS Level-0 data from Core Ground Stations and generate precise orbit data to the PACs for off line processing purposes.

3.4. **EUMETSAT Ground Segment Operations**

The EUMETSAT Ground Segment shall rely on the services implemented and provided by ESA, including Core Ground Stations for the reception of Sentinel-3. The Copernicus ground segment implemented at EUMETSAT may include functions and infrastructure shared with the other, non-Copernicus missions as part of EUMETSAT programmes. The EUMETSAT Copernicus ground segment shall provide data from dedicated (Sentinel-3 *Marine*, -4, -5, -6 and Jason-3) and contributing missions, including access by the users. The datasets and services provided by EUMETSAT shall be documented in the Service Level Specifications (SLS).

3.5. **European Data Relay System (EDRS)**

The European Data Relay System (EDRS) service shall provide the capability for the acquisition of Sentinels data complementary to the X-band core ground stations, allowing to support in particular quasi-real time observation needs (QRT is defined as products having timeliness of less than 1 hour). In particular EDRS shall provide the following capabilities:

(a) introduce flexibility in the overall data acquisition scenario leading to an increased availability of Sentinel data;

(b) allow to downlink data to ground while the Sentinels are outside the visibility of the X-band core ground stations;

(c) in combination with the X-Band core station network, support and improve the end to end availability and reliability of data provision to the end user;

(d) provide additional flexibility to accommodate Copernicus security-related requirements by 'protecting' the mission data reception via the encrypted EDRS Ka-band downlink.

The use of the EDRS service in support of the Sentinel-1 and Sentinel-2 missions shall provide further opportunities for product timeliness improvements, including beyond the current formal Near-Real Time commitment, defined as product timeliness of three hours.

EDRS shall allow performing fast downlink of data acquired outside the X-Band core stations visibility. Data shall be downlinked in pass-through mode via EDRS when observing such areas. This should in turn enhance the achieved product timeliness associated to core products. In addition, this should allow collaborative partners to generate products in QRT/NRT.

EDRS should be used to downlink a high percentage of data recorded in memory, outside X-band core stations visibility. This will in turn increase the volume of data downlinked and thus the volume of NRT data generated by the CSC ground segment.

The main functional tasks performed by the EDRS service shall be:

(a) sentinel-1 and -2 satellites data transmission via Optical (Laser) link between the OCP on-board the LEO satellites and the equivalent unit on-board the GEO satellites (EDRS-A and EDRS-C);

(b) mission data relay between the GEO satellites and the Ka-band ground receiving terminals;

(c) mission Data reception, decommutation and provision to the service interface point, including data circulation network.

The service shall be relevant to Sentinel-1 and Sentinel-2 missions (other Sentinels shall not carry on-board the necessary Optical Communication Payload). The geographical coverage area for downloading the Sentinel data to the EDRS receiving stations shall cover Europe as a minimum.

The service provided by EDRS shall be procured via a dedicated Service level Agreement contract, managed according to a set of stringent performance indicators.

3.6. **Overall operations and data acquisition strategy for the Copernicus dedicated missions**

The operations strategy for all Sentinels shall have the following objectives:

(a) to provide data to Copernicus and other users according to the specified requirements;

(b) to ensure systematic and routine operational activities with a high level of automation and with pre-defined operation to the maximum extent possible.

The Sentinel operations strategy shall be documented in a High Level Operations Plan (HLOP) which shall be made publicly available. The HLOP shall include information on observation/planning, acquisition, processing and dissemination.

The High Level Operations Plan shall be defined based upon the observation requirements from primarily the Copernicus Services, national requirements from Copernicus Participating States, relevant Union Institutions and other users including based on international agreements, scientific use and commercial value-adding. Based upon the collected observation requirements, a series of simulations shall be performed to elaborate the observation scenarios taking into account the priority schemes and technical constraints. Consultation with the Copernicus Participating states on both the collection of observation requirements and observation plans shall be done typically once every year at the User Forum.

The acquisition strategy shall adhere to the following principles:

(a) sentinel-1 acquisitions shall be performed according to a mission background plan;

(b) sentinel-2 shall be acquired systematically between 56° S and 84° North over land, coastal areas as well as larger islands;

(c) sentinel-3, -5p, -5 and -6 shall systematically acquire data over the entire globe;

(d) sentinel-4 shall systematically acquire data over Europe from a geostationary orbit.

3.7. **Data Products List from Copernicus Dedicated Missions**

Data acquired by the Sentinels shall be automatically downlinked to the core ground stations and systematically processed by the Payload Data Ground Segment. The data shall be systematically processed to generate a set of pre-defined core products (called Level 0, Level 1 and Level 2). These core products shall be made available to the Copernicus users ('user products') according to well defined timeliness ranging from Near-Real Time (NRT) to Non-Time Critical (NTC), available typically within 3 to 24 or 48 hours after being sensed by the satellite.

Table 3 lists the Data products that shall be made available from the Copernicus Dedicated Missions. The user products for Sentinel-4, -5 and -6 shall be specified during the development phase. A detailed list of all products shall be made publicly available.

Table 3

Summary Copernicus Dedicated Missions Data Products list

	User Product Category	Product content/Description
Sentinel-1		
	SAR Level 0	Compressed unfocused SAR raw data
	SAR Level 1 Single Look Complex	Focused SAR Complex data, georeferenced, provided in slant-range geometry
	SAR Level 1 Ground Range Detected Full Resolution	Focussed SAR complex data, georeferenced, multi-looked and projected to ground range geometry
	SAR Level 2 Ocean Product	Geolocated geophysical parameters (e.g. Ocean Wind Field, Wave Spectra and Radial Velocity)
Sentinel-2		
	Multi-spectral instrument Level-1	Top of Atmosphere Reflectance's in Cartographic Geometry
	Multi-spectral instrument Level-2 ([1])	Bottom of Atmosphere Reflectance's in Cartographic Geometry
Sentinel-3 (common for Marine and Land)		
	Ocean and Land Colour Instrument (OLCI) Level 1	OLCI Top of Atmosphere Radiances, ortho-geolocated and re-sampled
	Sea and Land Surface Temperature Radiometer (SLSTR) Level 1	SLSTR Brightness temperatures and Top of Atmosphere Radiances ortho-geolocated and re-sampled

	User Product Category	Product content/Description
Sentinel-3 partim Marine		
	Surface Topography Mission (STM) Level 2	Geophysical parameters over ocean (e.g. surface backscatter, sea surface height, significant wave height, ocean depth, tide height, sea ice concentration, sea ice freeboard, sea surface wind speed, rain rate)
	OLCI Level 2	Geophysical parameters over ocean (e.g. sea surface reflectance, algal pigment concentration, suspended matter concentrations)
	SLSTR Level-2	Sea Surface Temperature
Sentinel-3 partim Land		
	Surface Topography Mission (STM) Level 2	Geophysical parameters over land (e.g. surface backscatter, altimetry range, surface height, snow density and depth)
	OLCI Level 2	Geophysical parameters over land (e.g. photosynthetically active radiation, global vegetation index)
	SLSTR Level-2	Land Surface Temperature
	OLCI and SLSTR Synergy products	Geophysical parameters over land (Land surface reflectance's and aerosol load over land)
Sentinel-5p		
	TROPOMI instrument level-2	Ozone, Nitrogen Dioxide, Sulphur Dioxide, Formaldehyde, Carbon Monoxide, Methane, Aerosols, Clouds
Jason-3 (Europe-US cooperation mission, operations are funded by Copernicus)		
	Geophysical Data Records Level 2	Geocoded products corresponding to altimetry parameters.

([1]) The generation of Sentinel-2 Level 2 data shall be made available through the Sentinels Core Ground Segment or shall be enabled through a toolbox running at the users' side.

Note: Level 0 (L0), Level 1(L1) and Level 2 (L2) nomenclature refers to the subsequent level of processing of a product whereby L0 indicates unprocessed instrument and payload data, L1 indicates georeferenced and calibrated computed data and L2 refers to derived geophysical variables. For the Surface Topography Mission (STM), Level 2P & 3 products are also generated based on L2 products with enhanced geophysical corrections, bias corrections and adjustment of orbit errors.

3.8. **Developments aiming at modernising the Copernicus Space Component**

Changes (excluding policy changes that are agreed on a political level) in response to new or evolving user requirements that could be addressed through an incremental evolution of the current Copernicus Space Component Infrastructure may include:

(a) upgrade processing and dissemination infrastructure to increase performance;

(b) production of new products based on existing capacities;

(c) procurement of new datasets based on existing third party missions.

Short-term updates of the Copernicus Space Component shall follow a *change management* process including the following generic steps:

(1) identification of needed changes;

(2) initiation of the Change Request by either the Commission, ESA or EUMETSAT;

(3) analysis of the Change Request, including an analysis of impact (technical, cost, schedule);

(4) agreement by the Commission on the implementation of the proposed changes;

(5) implementation of the changes.

3.9. **Development activities aimed at mitigating operational risks**

In ensuring the protection of Copernicus satellites against the risk of collision ESA and EUMETSAT shall take into account the Union Space Surveillance and Tracking (SST) support framework established under Decision No 541/2014/EU of the European Parliament and of the Council ([1]). The respective measures shall have their bearing on the Copernicus Space Component with the inclusion of a function to provide SST services to spacecraft operators and public authorities.

4. COPERNICUS CONTRIBUTING MISSIONS

4.1. **General**

'Copernicus Contributing Missions' (CCM) shall mean space-based Earth observation missions providing data to Copernicus complementing data from the dedicated missions.

Data from CCMs shall be obtained by Copernicus to fulfil the data requirements as described in section 1, whenever these cannot be met by the Sentinels.

Data from CCMs could be either free of charge or could be procured under specific licensing conditions.

For datasets under restrictive dissemination conditions by the CCMs, the following user categories shall be applied:

(a) Copernicus Services;

(b) Institutions and bodies of the Union;

(c) Participants to a research project financed under the Union research programmes;

(d) Public authorities of EU Member States and Copernicus Participating States;

(e) International Organisations and international NGOs;

(f) The general Public.

4.2. **Overall Process**

On the basis of the Data Warehouse Document (see section 1) ESA and EUMETSAT shall undertake a joint analysis to identify which datasets would need to be procured, and which datasets could be provided without procurement through third party missions. The results of this analysis shall be documented in the joint Data Warehouse Traceability Document. The datasets shall be further described in the Data Access Portfolio (DAP) document, for what concerns the datasets provided by ESA, and the Service Level Specification (SLS) document, for what concerns the datasets provided by EUMETSAT. The uptake of the datasets shall be reported by ESA and EUMETSAT on a quarterly basis. Depending upon the uptake of the data and an analysis of the needs, the procurement/pursuing of third party data shall be adapted, as appropriate.

4.3. **Procurement of data from Copernicus Contributing Missions**

Licensing conditions for data shall be negotiated with contributing mission data providers for data that needs to be procured. These licensing conditions could depart from the open data policy.

Data procurement activities shall be under the responsibility of ESA and shall focus on providing Earth Observation data from national or international missions, both private and institutional. CORE Datasets shall be procured on the basis of pre-defined specifications while ADDITIONAL datasets shall be procured through a quota mechanism and bulk agreements with data providers for the provision of data within a financial envelope.

Procurement activities shall include:

(a) analysis of the requirements, derivation of specifications for data procurement and the selection of the relevant providers;

(b) procurement of the actual data on the basis of licenses or resource buy;

([1]) Decision No 541/2014/EU of the European Parliament and of the Council of 16 April 2014 establishing a Framework for Space Surveillance and Tracking Support (OJ L 158, 27.5.2014, p. 227).

(c) integration/de-integration of Contributing Missions into the Copernicus Space Component ground infrastructure;

(d) harmonisation and homogenous provision of data even in cases of large collections of data from different missions.

Procured datasets may include data from the following contributing missions (non-exhaustive lists, full list available for http://spacedata.copernicus.eu): Pleiades 1 A/B, Deimos-2, Worldview-1/2, Radarsat-2, TerraSAR-X, COSMO-Skymed (1/2/3/4), RISAT-1, Proba-V, GeoEye-1, SPOT-5/6/7 etc.

4.4. **Access to Contributing Mission data not requiring procurement**

Data Access to third party missions not involving data procurement shall be provided by ESA, including data from the Earth Explorers, and EUMETSAT, including data from the EUMETSAT missions.

EUMETSAT should ensure access to data from its own missions, as well as from selected third party missions related to the marine, atmosphere and climate change services. In this context, third party missions shall refer to missions operated by satellite operators with whom EUMETSAT has formal cooperation and/or data exchange agreements.

The activity shall encompass the following:

(a) access and provision of Copernicus contributing Mission data to the Copernicus services and users;

(b) processing of such data into relevant products, when appropriate;

(c) dissemination of these data and products using the EUMETSAT multi-mission dissemination infrastructure and services.

Datasets under this header may include data from the following missions: Meteosat, Metop, Suomi-NPP, Landsat, Cryosat and others.

5. COPERNICUS SPACE COMPONENT DATA DISSEMINATION

Data dissemination shall cover all activities and functions implementing and supporting the provision of access ('pull' service) and/or delivery ('push' service) of dedicated mission and contributing mission data to the Copernicus users. The CSC data dissemination shall include:

(a) dedicated data access infrastructures;

(b) user Services.

The Copernicus data access infrastructure shall implement the Copernicus Data Policy and shall be tailored to the needs of a predefined set of user typologies, namely Copernicus Services, Member States, International partners and other/scientific use. Data access and dissemination infrastructure shall include the following components:

(a) Data Access Infrastructure (Sentinel 'hubs');

(b) Online Data Access (ODA);

(c) Copernicus Online Data Access (CODA);

(d) Coordinated Data Access System (CDS) for data from contributing Missions;

(e) European Data Relay Satellite System (EDRS);

(f) EUMETCast;

(g) EUMETSAT Data Centre;

(h) Data and Information Access Services Infrastructure.

The Copernicus Space Component Data Dissemination systems shall include the available data products as listed in Table 4.

Table 4

Summary overview of the Copernicus Space Component Data Dissemination Systems

Data Dissemination System	Description	Available Data Products (current status)
Sentinel Hubs	Data Access Infrastructure operated by ESA allowing to retrieve Copernicus data for: Copernicus Services ('Copernicus Services Data Hub') Copernicus Participating States ('Collaborative Data Hub') International Partners ('International Data Hub') Open Access ('COA Hub')	Sentinel-1, Sentinel-2, Sentinel-3 Land
Copernicus Online Data Access (CODA)	Data Access Infrastructure operated by EUMETSAT allowing user to retrieve Copernicus data	Near-real time Sentinel-3 Marine, Jason-3
Online Data Access (ODA)	Data Access Infrastructure operated by EUMETSAT allowing Copernicus services and validation team members to retrieve Copernicus data	Near-real time Sentinel-3 Marine, Jason-3
Coordinated Data Access System (CDS)	Data Access Infrastructure operated by ESA allowing user to download data from Contributing Missions.	Contributing Mission Data
EUMETCast	Satellite and terrestrial -based multicasting service to deliver Copernicus near real-time EO products operated by EUMETSAT	Near-real time Sentinel-3 Marine, Jason-3 and Contributing Mission data distributed by EUMETSAT
EUMETSAT Data Centre	Provision of Copernicus Datasets and Products for the complete mission lifetime, orderable by end users using a search, filter and order mechanism.	Archived Sentinel-3 Marine, Jason-3 and Contributing Mission data distributed by EUMETSAT
Data and Information Access Services Infrastructure	Infrastructure that allows users to access, process and analyse Copernicus data and information	Data and Information from the Copernicus Space and Services Component

The Data Dissemination Systems shall serve different Copernicus user communities; the data available on each of the systems shall be optimised following the needs of those communities.

The ESA Sentinel Hubs shall be tailored to different user typologies (Copernicus Services, Participating States, International Partners and Other). They may differ in their configuration in terms of guaranteed performance, product offer and allowed number of simultaneous downloads.

The Copernicus Services Data Hub shall provide access to all Sentinel products within a specified timeliness (depending upon the product) and availability of the end-to-end service (at least 94 % available for each Sentinel mission constellation). The Collaborative Data Hub and the International Data Hub shall provide access to a rolling archive of Sentinel products with target performances. The Copernicus Open Access Hub shall be configured to avoid resources saturation resulting from massive downloads by a limited number of users.

The Copernicus Data Dissemination Infrastructure shall be continuously updated and improved to cope with the increasing user downloads and expanding data volumes to be distributed.

The User Services shall include features like user registration and management, discovery, view and download services, helpdesk and hosted processing services.

The Copernicus distribution services catalogues shall be interoperable amongst each other and provide complete catalogue information.

Detailed technical descriptions on the Copernicus data dissemination infrastructure and activities shall be made publicly available.

6. EVOLUTION OF THE COPERNICUS SPACE COMPONENT ON THE BASIS OF USER REQUIREMENTS

6.1. **General context and process**

The Copernicus Space Component evolution concerns the adaptations of the Space component beyond 2020 and beyond the current MFF. This chapter details preparatory activities necessary to support a decision on the future evolution of the Copernicus Space Component, within the framework of the Space Strategy. It details user requirements activities which shall be carried out under the current MFF as preparatory actions for the Copernicus Space Component Evolution. These activities shall take into account, where appropriate, elements of the ESA Long-term Scenario. Adaptations could include:

(a) Changes to the current Space Component Infrastructure;

(b) Development of Dedicated Copernicus Missions;

(c) Arrangements to obtain data from Contributing Missions.

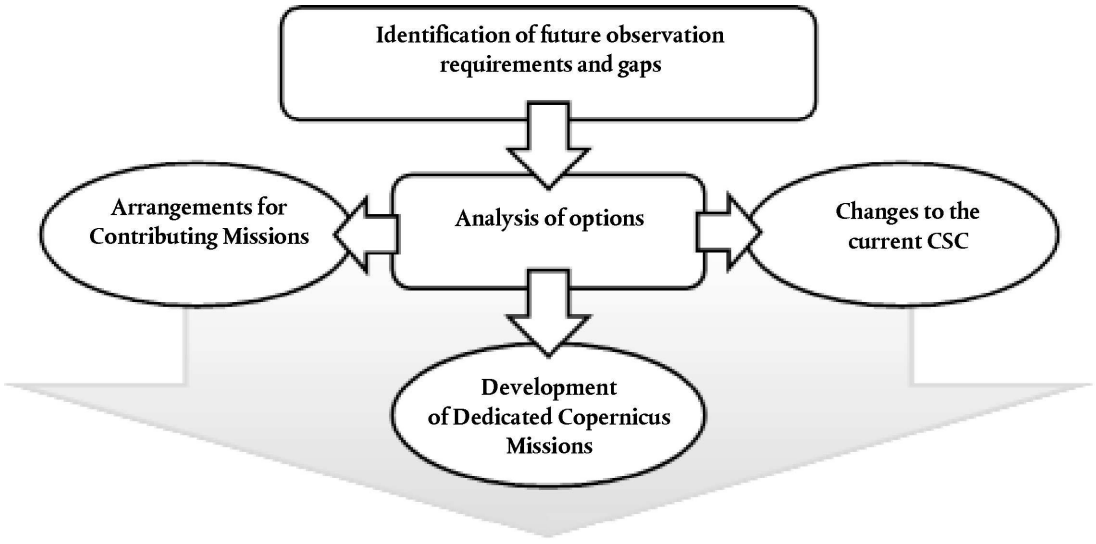
User requirement activities to be conducted to scope the evolution of the Copernicus Space Component (Figure 2) shall include:

(a) Identification of future observation requirements and gaps;

(b) Analysis of options to meet evolving observation needs, these options could include the adaptations listed above.

Figure 2

Copernicus Space Component Evolution Process



6.2. **Identification of future observation requirements and gaps**

The identification of future observation requirements and gaps shall be a Commission-led process which shall be supported by evolution-related activities conducted by the Copernicus Entrusted Entities.

The process shall consist of three major activities:

(a) Stakeholder consultation;

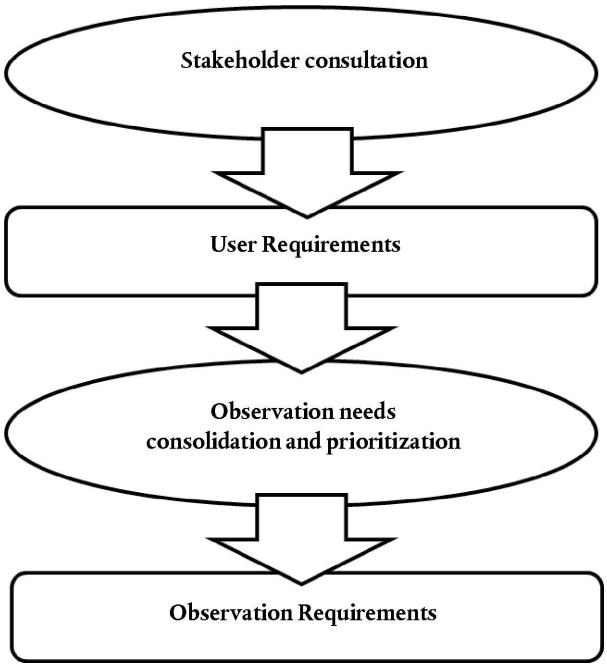
(b) User Requirements consolidation and prioritisation;

(c) Establishment of the observation requirements.

Figure 3 illustrates the overall process for establishing the Data Requirements and gaps.

Figure 3

Overall Process for Establishing the Data Requirements



Stakeholder consultation

The Commission shall conduct an extensive stakeholder consultation on user requirements. Observation and service requirements shall be collected through web-based surveys, workshops, user and market uptake activities, face-to-face meetings and existing processes and documentation. The consultation shall address the Copernicus community *at large*, specifically involving the Copernicus Services and Member States. The final documentation set shall cover **User Requirements** for all Copernicus thematic domains (marine, atmosphere, land, emergency, security and climate change). The User Requirements shall feed into the *Observation needs consolidation and prioritisation activity*.

User Requirements consolidation and prioritisation

The User requirements shall be consolidated and prioritised. This shall follow an iterative process, guided by the Commission, between the Space Agencies (ESA and EUMETSAT) and the Copernicus Core users (with a focus on the Copernicus Services, Union Institutions and Member States, represented by the User Forum). The stakeholder consultation documentation will require an in depth analysis in order to identify and organise user requirements according to underlying observation needs. This analysis shall include specifications on technical details with respect to timeliness, geographic area to be covered, update frequency in terms of temporal resolution, content in terms of observations and required accuracy.

As part of the process, the requirements shall be prioritised to allow an efficient assessment of various technological options. The prioritisation shall be conducted by the Commission and shall be assessed by ESA and EUMETSAT (evaluating technological aspects) and the Core Users expert group (to assess user aspects).

6.3. **Analysis of options to meet evolving data needs**

Analysis of options to meet evolving data needs should consider:

(a) Changes to the current Space Component infrastructure;

(b) Development of Dedicated Copernicus Missions and;

(c) Future arrangements to obtain data from Contributing Missions.

Changes to the current Space Component Infrastructure may include the addition of new products based upon on the existing Sentinels. Other potential adaptions may include the increase of a Sentinel constellation from 2 to 3 satellites post 2020 to address potential requirements for more frequent data.

Future arrangements to obtain data from Contributing Missions shall consider the Third Party data available and the identified observation needs.

Development of Dedicated Copernicus Missions shall consider:

(a) Definition of Next Generation Sentinels for continuity of observations beyond 2030;

(b) Definition of Expansion Sentinels to address Observation gaps starting from 2022-2025.

Analysis of options to meet the established observation requirements shall also take into account the following elements:

(a) Copernicus Technical Baseline and Space Component Technical Specifications;

(b) Outcome of the Mid-term evaluation of the Copernicus Programme;

(c) Impact Assessment of several evolution scenarios, including a cost benefit analysis.

Furthermore, the analysis shall take into account technical elements such as the availability of Third party missions and technology readiness levels.

6.4. **Establishment of Technical requirements for new dedicated missions**

Whenever the option for new dedicated missions is selected, a mission analysis shall be conducted which includes:

(a) Elaboration of the Mission statement based on the Data requirements, including expected performance;

(b) Technical requirements specification;

(c) Identification of possible mission concepts;

(d) Assessment of programmatic aspects;

(e) Risk Assessment.

The outcome of this analysis shall be detailed in a *Mission Requirements Document* and forms the basis for possible further satellite development and operations phases.

6.5. **Timing and progress of the Space Component evolution activities**

6.5.1. *General Timeline*

The general timeline for the evolution of the Space Component shall include the activities as shown in the table below.

Time	Activity
until 2018	— Stakeholder consultations
until 2018	— Technical Baseline of Copernicus — User and Observation requirements — Mid-term evaluation of Copernicus — Impact Assessment of Copernicus evolution scenario's
until 2018	— Legislative proposal for the Copernicus Regulation covering 2021-2027 — Establishment of Technical Requirements for new missions
2019 – 2020	— Preparatory activities for potential CSC evolutions

6.5.2. *Progress of the Space Component Evolution activities*

The Copernicus Space Component evolution preparatory activities shall respond to the general orientations as provided in the 2016 Space strategy, in particular the preparatory activities shall consider the user requirements for:

(a) 'continuous improvement of current services and infrastructure' and;

(b) 'additional services to meet emerging needs in specific priority areas':

(1) climate change and sustainable development, to monitor CO_2 and other greenhouse gas emissions, land use and forestry, and changes in the Arctic;

(2) security and defence to improve the Union's capacity to respond to evolving challenges related to border controls and maritime surveillance.

The following generic observation needs shall be considered when defining future evolution scenarios:

(a) **Continuity of observations**: As a key priority, users indicated the need to ensure continuity of observations, beyond what is currently planned, with on the long-term potential improvements in terms of spatial resolution, update frequency, timeliness

(b) **New observations in response to emerging needs**:

(1) Monitoring of anthropogenic CO_2 emissions;

(2) Monitoring of polar areas to support operational (ice) monitoring and/or climate change applications in the context of the EU Arctic Policy;

(3) Enhanced monitoring for agriculture and forestry, in particular to support water and biodiversity applications;

(4) Enabling of novel applications for mining, drought monitoring, cultural heritage, hydrology, biodiversity, soil moisture and other parameters, requiring observations, currently not available;

(5) Enhanced security applications;

(6) Monitoring of environmental implementation compliance and crime applications.

Preparatory activities to support future Copernicus space component scenarios may include:

(a) **Groups of domain experts**, to analyse the high-level programmatic context, state-of-the-art and concept feasibility to support the definition of Task Forces. Groups of domain experts shall be established to assess monitoring needs related to Security and Anthropogenic CO_2 emissions;

(b) **Task Forces**, to elaborate and further fine-tune the observation requirements, as well as to analyse potential technical solutions with the objective to specify initial mission requirements. These analyses shall take into account current observation capacities and the renewal/upgrade of the existing infrastructure, technological maturity and the potential for international cooperation. In particular the following Task Forces shall be established:

(1) Anthropogenic CO_2 emission Monitoring;

(2) Polar Observations;

(3) High spatio-temporal resolution Land Surface Temperature Monitoring, to address applications for agriculture, hydrology, forestry and the environment at large;

(4) Hyperspectral Imaging to enable innovative applications in biodiversity, mining, agriculture and forestry.

(c) **Preparatory Studies**, as an input to the work of the Task Forces;

(d) **Consultation** with EU Member States, Copernicus Participating States, ESA and EUMETSAT Member States, to ensure alignment of priorities and ensure consistency with the content of the ESA Long Term Scenario.

Based upon these activities, scenarios for the evolution of the Copernicus Space Component shall be examined including a thorough cost-benefit assessment.

The Copernicus Space Component evolution shall be tailored to the available budget of the next Multiannual Financial Framework and to the funds mobilised by EU, ESA, participating Member States and potential additional funding sources. With these constraints in mind, evolution scenarios could be:

(a) baseline evolution scenario: a sustainable Copernicus, that foresees the programme at its current level of performance, including continued operations of services, necessary renewal/upgrade of the existing infrastructure, actions in support of improved data access and distribution and support to user uptake beyond 2020;

(b) evolution and expansion scenario: a sustainable and expanded Copernicus considering two priority areas to address emerging needs:

(1) new observation capacities in support of environmental needs focussed on Climate change (e.g. monitoring of CO_2 and other greenhouse gas emissions for which no satellite observations are currently available), observations of the polar regions (focussed on the monitoring of sea ice and weather in the Arctic) and support to Agriculture including the monitoring of water related parameters which could be addressed through thermal infrared observations;

(2) new observation capacities in support of security and/or defence needs to address the new challenges the Union faces in terms of security, migration or border control.

The outcomes of the User Requirements process, cost-benefit analysis, technical feasibility, maturity of the technological solution, and overall affordability shall define the technical boundary conditions for the Copernicus Space Component evolution beyond 2020.