

# → SENTINELS COLLABORATIVE GROUND SEGMENT WORKSHOP #16

04–05 December 2018 Executive Summary



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**European Space Agency** 

#### **BACKGROUND**

The Copernicus Sentinel family of satellites is being developed to meet the operational needs of Europe's environment monitoring programme, Copernicus. The firsts in the fleet, Copernicus Sentinel-1A, Sentinel-2A, Sentinel-3A and Sentinel-5P were launched in April 2014, June 2015, February 2016 and October 2017 respectively. The first three Copernicus Sentinels are now accompanied by their sister satellites: Sentinel-1B, launched in April 2016, Sentinel-2B, launched in March 2017 and Sentinel-3B, launched in April 2018.

Copernicus is the European Union's Earth Observation and Monitoring Programme, headed by the Commission (COM). ESA coordinates the delivery of data from upwards of 45 satellites, comprising the Copernicus dedicated missions (Sentinels) and the Copernicus Contributing Missions. The Commission is responsible for the overall initiative, setting requirements and managing the Copernicus services.

The Copernicus Space Component (CSC) – coordinated by ESA – includes the development and operations of the Copernicus Sentinel satellites, as well as the distribution of the acquired Earth observation data. All Sentinel products are freely accessible online for the worldwide user community at **www.copernicus.eu** and **sentinels.copernicus.eu** 

In addition to that, and in close coordination with the Commission, ESA facilitates cooperation activities with Participating States to the Copernicus and the GMES Space Component Programme (including Canada) for direct and efficient access to Sentinel data. In the framework of the Sentinels Collaborative Ground Segment, potential activities of those countries are the set-up of a national mirror site, employment of their own local passive receiving stations, development of innovative data processing tools and applications and complementary calibration/validation activities. In any Participating State, various initiatives and entities can be involved in the cooperation. Therefore a National Point of Contact bundles the flow of information between the national entities and ESA.

Under the lead of the Commission, ESA implements a similar cooperation scheme also with further European countries and international partners.

#### WORKSHOP CONTEXT

The Sentinels Collaborative Ground Segment (CollGS) workshops provide a platform for information and discussion between ESA, the National Points of Contact, national entities involved in the cooperation and COM. The workshop succeeds the yearly meetings of the "GMES Operations Consultation Group", which started in 2010. In order to foster coordination among the CollGS initiatives, workshops are organised by ESA yearly.

The objectives of workshop #16 were to:

- Report on the latest Copernicus Space Component (CSC) developments: programmatic and technical
- Update on the latest status of the various Collaborative initiatives established by GMES Space Component (GSC) and Copernicus Participating States
- Promote the coherence between the CSC Ground Segment and Participating States collaborative initiatives
- Provide a forum for participants to harmonize their plans
- Address specific issues in the areas of:
  - Data access evolution for offline access and on demand requests
  - Product lifecycle evolutions
  - Data Hub architecture evolutions
  - Collaborative Ground Segment reporting dashboard

The workshop took place on 04-05 December 2018 at ESA/ESRIN in Frascati, Italy. 32 external participants attended the workshop, representing 19 countries.

Jolyon Martin, ESA, welcomed the workshop participants and introduced the workshop objectives. Participants were informed that a JIRA project has been made available to provide technical documentation and allow the submission of review comments.

ESA provided an overview of the latest status and prospect of the Copernicus Space Component, including the overall technical implementation status and the status of the Sentinels missions and the Sentinel data access and the current status of DIAS operations.

Individual presentations from ESA and Data Hub contractors then addressed specific topics in greater detail. These included the status and outlook of the Copernicus Sentinels Data Hub Service, Data Hub evolution for off-line access, Copernicus Ground Segment operations transformation, the pilot implementation of product on-demand transformations, reporting from CollGSs and foreseen product lifecycle evolutions.

Interleaved with the ESA presentations were 12 presentations from Member States and Copernicus Participating countries, addressing the progress of national CollGS initiatives.

## WORKSHOP HIGHLIGHTS -

Participants perceived the workshop as very useful to ensure coherence between the CSC development and national CollGS initiatives. The main highlights of the workshop are summarized below.

2018 has seen the completion of the Sentinel's family in orbit, with the launch of Sentinel-3B on 25th April. Sentinel-3B and Sentinel-5P are currently in the ramp-up phase, while all others are now in routine operations. Major evolutions in the year included the introduction of new Sentinel products and missions, for example the first Sentinel-5P products in July and Sentinel-3 Synergy products on the PreOperational hub from October. The transfer of Sentinel-3A products from the PreOperational Hub to the ColHub and Open Hub has continued; Sentinel-2 L2A worldwide products distribution is foreseen for by the end of 2018; Sentinel-1 L0 and L1 GRD products are now available in NRT on the ColHub covering Europe. Off-line retrieval of Sentinel-1 products began in the September, with the activation of the on-line rolling archive; the extension to Sentinels-2 and -3 products is foreseen for Q1/2 2019.

DIAS operations formally began in June 2018 following a phasein over the first half of the year. Activities in the first quarter of operations focused on the completion of data offers with the aim of reaching a steady state of operations. Planned data offer increases on the various DIAS platforms is targeted between the end of 2018 and mid-2019.

A new benchmarking activity for Copernicus Sentinels data access, including the DIAS, is intended to kick-off in Q1 2019, with the first reported expected by the middle of next year.

A major activity to transform the Copernicus Ground Segment is planned to take place between now and the end of 2021. Key objectives are the simplification of data flows, the streamlining of interfaces across the services and the transfer of operations, including production, to the cloud. Key evolutions include optimising the size of Long Term Archives (LTAs) while ensuring the availability of all data, the introduction of on-demand processing and the reinforcement of product traceability and consolidation of product life-cycle management. All evolutions will be implemented in parallel with on-going routine operations, with no impact on operations continuity and performance or on user interfaces, particularly for data access.

Management of product lifecycles will become a significant challenge as on demand processing becomes widespread, replacing the current well-identified production baselines managed centrally by ESA. ESA is investigating methods for managing the provenance of Sentinel products and will release a 'Product Lifecycle Operations Concept Technical Note' in early 2019 for comment and review.

The operational status of ESA's Sentinel Data Hubs was presented, with the focus on the ColHub. Since the opening of the ColHub in 2015 a total of 28 PiB of products have been downloaded: 13 PiB by CollGSs and 15 PiB by DHRs. DHuS software is being progressively evolved and rolled-out, together with open source versions. DHuS v2.0 will be in operation from January 2019 and include performance enhancements, support for new EO products and scalability improvements. DHuS v3.0 is planned for summer 2019 and will many other features. Substantial Data Hub architecture evolutions are being implemented and were previewed at the workshop.

Collaborative Ground Segment providers will be given the possibility to contribute usage statistics to the Sentinel Data Dashboard. These will include, for example, the status of operations, the number of registered/active users and volume/numbers of downloads by mission, period etc. Appropriate level of statistics provision will be evaluated on a case-by-case basis. A 'CollGS – Sentinel Data Dashboard ICD' has been made available for review and comment.

Many national activities, in particular Sentinel data mirror sites, and generation of high-level products and services are operational. Provided services offer in some cases Sentinel data along with other mission data and hosted processing capacities. In particular, the following highlights were presented: **Austria CollGS**: The Austrian Collaborative Ground Segment comprises two parts. The first part includes the Sentinel National Mirror Austria and a Data Hub Relay operated by ZAMG, while the second part is represented by EODC. EODC provides access to a global Sentinel archive accessible in a hosted processing infrastructure. Following three years of experience in set-up and operations, preliminary conclusions indicate a clear gain in experience and growth as a catalyser for Copernicus user uptake activities. Ongoing activities include the implementation of a single API for EODC base services, compatible with openEO, the federation of EODC and the WEKEO DIAS and plans to further expand in a stepwise sustainable manner, continuing to federate activities to enable advanced EO services.

**Belgium CollGS**: Since the agreement signed between ESA and BELSPO in September 2017, VITO (the designated entity for the CollGS) has released both the website in December 2017 and, in March 2018, Terrascope, the Belgium platform to access and use Copernicus Data. The platform includes the Terraviewer, an EO browser, and the focus has been on easy access for users and support for APIs. Notable features include feature comparison in a single window via a slider and time series analysis for specific AOIs. Future planned developments include DIAS exploitation, inclusion of new datasets and the introduction of pre-configured virtual machines built on PROBA-V PDGS infrastructure from Q1 2019 onwards. An active approach has been taken towards informing industry, the public sector and the education system through a roadshow.

**Czech CollGS**: The Czech CollGS is managed by the Ministry of Transport and developed and operated by CESNET. A National Mirror has been available since late 2016 and a DataHub Relay (DHR) since spring 2018. National Mirror infrastructure has undergone integration with the European Open Science Cloud and the European Grid Initiative (EGI), and CESNET have developed a plugin for the OneData agregator in EGI to access the DHuS. Additionally support has been provided for the integration of DHuS as a source for ArcGIS image layers. An expert group consortium is planned to be established, highlighting the need for common routine algorithm processing for atmospheric correction, cloudless mosaicking and metadata/annotation. Developments on the DHR have focused on the monitoring of service health and performance and reporting and analytical tools. **Finland CollGS**: The Finnish Collaborative Ground Segment Finland consists of a local mirror site for Sentinels' data, data processing services and a local reception station for Sentinel-1 Direct Broadcast, the latter focusing in particular on supporting the Baltic Sea Ice service. FinHub, the National Mirror, has been open to the public since May 2015 and, with an AOI that principally covers the Baltic Sea drainage basin, is used mainly by Finnish research institute users. Processing services consist of a virtualization environment for operational product processing and hosted processing, with leverage 'big data' technologies. An intended application is the bulk processing of data for local use, for example S2 L1b to L1c processing using the national DEM.

**France CollGS**: The PEPS mirror site platform was opened in September 2015 and now has over 4000 registered users. It offers three main functions: a mirror site for Sentinels-1, 2 and 3 data products, a processing workshop allowing 'first level' treatments, results visualisation and product downloading functions, and an incubation of mature processing chains for 'scale' validation. During 2018, regular upgrades have been made during 2018 to acquire new Sentinel products and a complete release of the PEPS processing functions was made in June 2018. Two 'flagship' treatments provided are the orthorectification of Sentinel-2 products vs the S-2 grid and the Sentinel-2 ground reflectance using MAJA (the latter has been available since October 2018 and around 1000 requests have now been processed). Functions soon to be made available are multi-date processing and a soil moisture product mixing S-1 and S-2 data.

**Germany CollGS**: The CODE-DE data and exploitation platform has been operational for data access since March 2017, offering open view and discovery services, as well as download following self-registration. On-demand processing access is also available, providing a free-ofcharge, scalable environment and a number of open processing resources. In general, the platform stores products on a global-scale for 1 month, on a European-scale for 12 months and over Germany for 36 months. Funding is currently allocated until 2024, with planned evolutions including the integration of Sentinel-5P and -3B products, the addition of more value-adding processors, a data cube technology is currently tested.

**Greece CollGS**: The Hellenic Sentinel Data Mirror Site is the fruit of the collaboration between the National Observatory of Athens (NOA) and

the Greek Research and Technology Network (GRNET). It offers products over an extended Mediterranean AOI with a 25-day rolling archive. By December 2018, the service had 610 registered users, largely from the scientific community, and over 28 TiB of downloads during the last year. Several national scale applications are supported through the BEYOND Center of Excellence hosted by NOA such as the monitoring of floods and forest fires. BEYOND has recently set up the so-called GeObservatory, a new service activated during major geohazard events and which automatically produces interferograms from Sentinel-1 images directly downloaded from the Hellenic Sentinel Data Mirror Site. New evolutions include support for academic user authentication via single sign-on and the implementation of an EO toolkit linux image allowing users to straightforwardly create VMs with direct access to the Hellenic Data Mirror Site and basic remote sensing processing tools. A link to the EOSC (European Open Science Cloud) hub has been created, as well as the creation of a free course on the online GEO University.

**Netherlands CollGS**: The current 'Pre-Copernicus' Satellite Data Portal has been available since 2012, offering basic FTP access to users based in the Netherlands from a portfolio of Radarsat-2, Planetscope and Triplesat constellation products. At present, no Collaborative Ground Segment has been established. A 'Technology Roadmap for Ground Segment Data Processing' is currently undergoing an extensive revision and will consider how to move forward with the CGS initiative, taking into account the now available DIAS framework.

**Norway CollGS**: The aim of the Norwegian Collaborative Ground Segment is to simplify access to Sentinel data, ensure support for national services and preserve data for the Norwegian AOI. Sentinel data is distributed via two portals: colhub.met.no and satellitedata.no: the former runs the DHuS software suite and serves operational needs while the latter is an open data space, transferring satellite data to netCDF format to facilitate the integration of non EO data, such as meteorology and oceanography products. At present, colhub.met.no serves some 430 users. Planned developments include orthorectification of Sentinel-1 products, Sentinel-2 products in netCDF format, an OpenSearch API on index metadata and a virtual research environment. InSAR Norway was opened in November 2018, using Sentinel data to provide operational subsidence data production over Norway.

**Poland CollGS**: The Polish Collaborative Ground Segment agreement was finalised with ESA in 2018 and is currently in development. It

will be managed, developed and operated by a consortium of the Institute of Meteorology and Water Management (IMWM), the Crisis Information Centre (CIC) and the Polish Space Agency (POLSA). The CollGS will consist of a Copernicus Portal comprising of an EO cloud, data archive and basic tools, and will connect all thematic platforms working with satellite data (including crisis management, hydrology, agriculture, meteorology, geology and spatial planning). A system of Thematic Exploitation Platforms is planned for 2019.

**Romania CollGS**: Following the signature of Collaborative Ground Segment agreement with ESA, a Romanian mirror site has been set up and is at present in its validation phase. The site will provide access to products from all Sentinel missions, with a rolling archive of one month and an AOI initially covering Romanian territory and later to be extended to cover the entire Danube basin. It is intended to be a central point of access to organisations requiring bulk downloads (e.g. Meteo Romania), universities and R&D organizations. Highlights include data mining in time series, content-based image retrieval and a 'Suitability Coverage Engine' (SUCE) for letting users discover the most appropriate data for different applications. The goal is to provide reliable and sustained access to satellite and in-situ data, continuing the current developments to full implementation which will eventually include data cube technology and thematic portals.

**UK CollGS:** The current UK CollGS includes SeDAS, operated by Catapult and serving commercial users, and JASMIN, operated by STFC-RAL and providing academic data access. Both are operational and supported by Data Hub Relays for Sentinel data collection. The figures below are those used in a December 2018 presentation. SeDAS maintains a minimum one year rolling archive of Synthetic Aperture Radar (SAR) data from Sentinel 1A and 1B as well as Optical data from Sentinel 2A and Sentinel 2B. It also has access to the full mission archives. Latest figures at the time of the presentation showed it had 670 registered users from 65+ countries. JASMIN currently mirrors 5 PB of data from all Sentinel missions; although 592 users (at the time of the presentation) made downloads in the last 12 months, most users have made use of data directly on the platform. JASMIN now supports around 200 science projects as well as virtual research environments (e.g. ESA's Polar Thematic Exploitation Platform). UKSA has set up the EO Data Group to bring together key partners across industry, academia and Government to consider issues relating to EO data access and exploitation. This will coordinate the UK approach to satellite EO data policy and infrastructure activities and support our Data Vision. Next steps for the data programme involve analysis of user requirements and the evolving complex nature of international data activities, including the evolution of the Copernicus Ground Segment and DIAS.

### WORKSHOP DISCUSSION POINTS AND RECOMMENDATIONS

it was considered that data access for CollGSs is overall well consolidated with very good performances. DHRs are considered particularly useful, with a high volume of data being exchanged through them. With respect to the future evolutions, it was stressed that data access will need to continue with same performances and so evolutions will be carefully monitored.

It was highlighted that the Collaborative Ground Segment has proven a useful framework to share technology and prototypes and ESA intends to continue in this direction. ESA consider the forum useful to exchange information on technical specifications projected to be used in the future evolutions of the Copernicus Sentinels Ground Segment.

The participants considered the workshop a very useful platform to share experiences and exchange ideas. A number of common topics and themes were addressed, in some cases leading to recommendations being made. These included:

- It was noted that many CollGSs are now operational, with more expected soon, and that the DIAS platforms are also becoming operational. There was some discussion as to whether the DIAS platforms could replace functions currently performed by the Core Ground Segment. ESA stressed that the objectives of the Core Ground Segment are considered distinct from the DIAS, the former intended for opening data to national initiatives in a timely, dedicated and secure fashion, the latter orientated to support commercial offers from any interested party. However, interoperability between the DIAS and national Ground Segments needs to be investigated and could certainly benefit end users.
- Now that many national CollGSs are operational, it was highlighted that synergies are appearing between services and that opportunities are emerging to develop what is currently an ensemble of isolated nodes into an integrated infrastructure. This is clearly a major challenge and merits further investigation and discussion.

- There was interest in whether the upcoming benchmarking activity would include national CGS elements in addition to the ESA-operated Data Hubs. ESA clarified that a key output of the activity will be a software package, which could be provided to the CollGS providers if they wish to perform internal benchmarking.
- A discussion took place regarding the CollGS reporting information requested to be made available on the Sentinel Data Dashboard, particularly regarding its scope and audience. Some providers requested additional context from ESA/EC to provide information on who the Dashboard might be opened to in the future (currently the audience is restricted to internal users). Potentially some statistics could be aggregated and not shown for individual providers. Further discussion is needed.
- The implementation of on demand processing via cloud providers was discussed. ESA noted that the scope of the current workshop is to ensure access to technical solutions and does not cover ESA's procurement approach. The objective is that there should be no impact on Core Ground Segment operations and for the solution to be flexible and scalable (e.g. through the use of multiple cloud providers). Product baseline management/provenance/traceability in the on-demand framework is a complex question and will require detailed discussion in future forum.
- Several CollGS providers expressed an interest in receiving Sentinel-2 L1b data from ESA. ESA will investigate how this could best be achieved: given the potential volume of data there would be an impact on current resource sizing (e.g. online archives) and a limitations may need to be considered.
- It was highlighted that current Sentinel product formats (e.g. SAFE), though necessary for expert users' needs, can be difficult for non-expert users to handle. A discussion took place as to where transformations to other formats, e.g. PNG, should take place, either directly from ESA on the CollGS platforms. Such transformations will be investigated as part of the ESA's future 'on demand processing' developments.

ESA, in continued coordination with the Commission, will follow up the recommendations made and report on the status of their implementation at the next Sentinel ColIGS – technical – workshop, #17.

ESA 2016