COPERNICUS: HOW TO FURTHER ENHANCE THE IMPACT OF A WORLD-CLASS EUROPEAN PROGRAMME

RECOMMENDATIONS FROM THE EUROPEAN SPACE MANUFACTURING INDUSTRY

Introduction

Copernicus is one of the most prestigious European programmes. This public services Earth Observation (EO) system is considered as a **world-class reference** for climate change and environmental monitoring. It therefore directly contributes to addressing and finding solutions to some of the major challenges of the coming decades for all European Union citizens, and to **supporting Europe's role on the world stage**.

Copernicus continuously delivers an **enormous quantity of data** responding to the needs of a vast ensemble of worldwide users, who utilise Copernicus services with full confidence in their quality, durability and robustness. The excellence of the Copernicus services is directly linked to the very **high-quality set of Copernicus observations and measures** that can only be provided by the state-of-the art of this space system. As a result, Copernicus has become the **globally-accepted standard for science-grade imagery and EO data quality**.

From an industry perspective, **Copernicus is a structuring programme for the European space sector** as it enables it to master world-class technologies for operational and reliable remote sensing.

More precisely, it allows equipment suppliers to develop and maintain performant and reliable products, featuring technological innovation and recurring models with mini-series, contributing to ensure a "critical mass" of activities to space satellites manufacturers, and providing continuity to the EO manufacturing industry; this in turn positively impacts industry's product policies. Indeed, the cutting-edge technologies and products developed in the frame of the Copernicus programme can then be used for future commercial and export customers as state-of-the-art and "ESA proven" branded products, making a qualitative differentiator. It is probably not a coincidence that, today, Europe is the word leader of EO systems on the export market!

In short, in addition to being a key asset for Europe to position itself as a world leader in environmental monitoring, **Copernicus is also an excellent showcase for the European space sector on the open markets**, as well as for supporting political recognition of space in Europe.

At several occasions during the beginning of this year, Commissioner Breton noted that the current context is requiring a thorough reflexion about the evolution of Copernicus, to address both the increased pressure from the market and the development of new technologies, as well as the new needs in a dramatically changing new geostrategic and environmental context. This evolution of Copernicus would offer users higher responsiveness to address urgent needs, a greater frequency of revisits, the integration of new technologies as well as an openness to the contributions that new endeavours in low orbit can provide.

In this context, **this paper is a first contribution of the European space industry to the discussion about the evolution of Copernicus**. In this document, industry wishes to highlight the key features of the programme which we consider that the evolution should be built upon, and to propose a number of improvements that should be implemented to further enhance the impact of the programme. The paper also presents guidelines regarding the future integration of commercial EO capabilities developed by the private sector within the programme, and makes recommendations about a possible extension towards a Copernicus government service intended to increase the security and resiliency of Europe.

Key strengths of the programme, from an Industry point of view

Copernicus represents an unrivalled reference source of data, well-known and valued by numerous scientific, institutional and private entities all over the world. The main features that are making Copernicus the greatest EO programme ever developed are:

- Driven by user requirements;
- Recognised quality: state of the art sensors and missions;
- Long-term continuity of observations supporting science, policy makers and the development of business cases;
- Open data access: free provision of data openly accessible to users.

Copernicus Sentinel missions offer unparalleled performances, reliability and unprecedented dataset quality and continuity. They allowed Europe to take and maintain a technological and scientific lead globally in this domain. By being an indispensable reference for cross-calibration of third-party missions, including some commercial ones, the Sentinel missions are allowing the European EO community to rely on European sources for validation and calibration. Moreover, continuity of data is key for all users, whether scientific, institutional or commercial, and for granting the necessary sustainability and foreseeability to an expanding downstream and value-added ecosystem.

At ground segment level, the new approach promoted by Copernicus has prompted the industry towards a "ground segment as a service" approach in a cloud environment. The current system where ground segment operations, data access and calibration & validation functions are today outsourced to industry (in the form of service-oriented contracts based on a cost model and a Service Level Agreement) is considered both efficient and beneficial to support industry capabilities and competitiveness.

At space segment level, upcoming Copernicus Expansion and future Sentinel NG (Extension) are not only based on innovative payloads, but they also started the integration of key innovation features and "New Space" approaches in both space and ground segments, to unlock the potential of the very large and information-rich datasets that they will generate. This further links to the rapidly-developing and diverse environment of digital twin modelling

As already in place in the frame of the Copernicus Expansion, **future Sentinel NG will also maintain a welcoming environment for European smaller space industries**, allowing them to secure their involvement with sizeable packages, including high-value subsystems (e.g., power, antennas, data handling).

More generally, publicly funded R&D has led to significant advances in the precision of sensors, high data-rate transmission and in High Performance Computing; these advances and the massive use of AI algorithms have enabled massive processing of a huge amount of data, which is in turn supporting digital twin modelling. Further progresses leading to increased revisits, higher sensors precision, faster insight elaboration and transmission will remain key to build new services for both public and commercial actors.

Also, the use of common standard platforms should be further investigated in the frame of Sentinel Expansion and Extension as a possible way to support cost-effectiveness and risk mitigation.

Further improving Copernicus

Increased cost-efficiency through improved procurement approaches

As industry has matured in its capabilities (i.e., products and missions) over the last 15 or more years of the development of the Copernicus system, it appreciates the growing flexibility shown already by ESA in procurement and management of space and ground segments system design and development. **Tools such as full-consortium procurements have shown their strengths** in appropriate circumstances to accelerate programme development. Building on this, higher delegation by ESA of the contract execution (after a "freezing" of the mission definition and requirements) would be welcomed, linked to a shared vision of risks between ESA and Industry.

Furthermore, the schedule and cost benefits of allowing industry to optimise its planning, resources and facilities across manufacturing runs of 3 or 4 identical satellites could be very important, provided that a continuity in the funding and procurement scheme and more flexibility in the geographical distribution can be envisaged. Such a longer-term stability would ensure a more stable base for the whole European supply chain, allowing industry to deliver high performance, innovative and inclusive technological developments.

While it did help overcoming important institutional constraints, industry notes that the (although smart) parallel procurement of several missions was challenging, mostly linked to its complexity and length. Nonetheless, it showed, reassuringly, that it is possible to combine procurement approaches satisfying at the same time the expectations from Member States in an ESA framework and the ones of the EU; and the creativity of the institutions to overcome the existing constraints was greatly appreciated.

Looking ahead and to **further improve the balanced participation of smaller entities**[1], strategies to remove the barriers (financial, administrative…) that are preventing their participation will help to enrich the proposed consortia with relevant new players, tailoring and qualifying their technologies for space environment.

Finally, a certain lack of stability of the public funding needs to be addressed as it creates a more complex procurement scheme, leading to otherwise unnecessary milestones rather than reflecting the long-term commitment of the institutional customers. **A longer-term funding stability would ensure a more stable base for the whole European supply chain**, required to deliver the high performance, innovative and inclusive technological developments that Europe demands.

With respect to services, industry needs a **sufficient level of service continuity and committed business volume** to guarantee investment in new applications.

Improving access to- and usability of- Copernicus data

Improving access to Copernicus data requires not only considering the space data users' needs but also the **uptake of Copernicus information by other industrial domains** as part of their operational processes and by the citizens to support the daily information demand. Currently, the Copernicus services are elaborated for specialised users, which are skilled in the use of the technology and understanding of the Copernicus data.

[1] *Looking ahead, industry considers that if procurement policies are put in place with the aim to secure the involvement of different company typologies (namely Large Space Integrators - LSIs, subsidiaries of LSIs, independent midcaps, SMEs), with target business shares, then they should be as consistent as possible with the respective weight of these segments in the European space sector business and employment.*

Facilitating the access to Copernicus data and derived information to a broader scope of users is of utmost importance.

Improving the usability of data requires technical optimisations. Improvements of the revisit time and data latency and associated infrastructure would allow to support real-time applications, exploiting on-the-fly data processing and specific event analyses. This would also require increasing the mechanisms to facilitate user-oriented "information concentration" such as through on-board & on-ground processing and user-friendlier interfaces.

In addition, a huge part of the end-user service costs is dedicated to Cloud resources and their micro-services, often owned by GAFAM. To help solving this issue, European Institutions shall express strong preference for European hosted cloud and micro-services for their own service needs.

Worldwide, **institutions are key user of EO data and services**. A critical step to further improve the uptake of EO data for policy-making (as well as for evidence for law enforcement) is the **certification of the data** and its derived information products. Such certification shall guarantee the full data traceability and integrity throughout its acquisition, storage and processing into usable information. Furthermore, certification level should be based on user categories expressed needs.

Copernicus as a contributor to "space sustainability"

The Sentinels, as other satellite components of the European Space Programme, are good candidates to demonstrate European industry capabilities for end-of-life management, debris reduction…. Next requirements shall therefore also be focused on designing and manufacturing solutions that will enable:

- Sustainability: For managing the space assets today and tomorrow;
- Scalability: For providing new functionalities to the future space systems;
- Flexibility: To adapt to the missions of tomorrow.

How to best complement the Sentinel missions with capabilities from the private sector?

A **data-buy policy**, aiming at completing the public infrastructure, is the relevant mean to implement a Public-Private-Partnership between European institutions and European companies delivering EO data. This data-buy policy should aim at high quality data and science-grade imagery able to complement the data from the different Sentinels missions, in a seamless way for the users. From an industrial perspective, the adjunction from the traditional "infrastructure acquisition" approach to a scheme consisting in the "long-term commitment to the purchase of services" would allow private operators to further leverage their investments by selling additional services on secondary markets at marginal cost. This development could have medium/long term effects and in particular the diversification of technical responses, and may eventually promote:

- Innovation in industrial processes;
- Innovation in infrastructure and systems;
- The emergence of new players;
- The emergence of new markets for services.

A data-buy policy should come in parallel to the **extension of services under the Copernicus umbrella to cover regional and local needs**. Entrusted Entities, acting as service providers, should take care of the procurement of such services in a similar way as the current Copernicus Services, applying standards and quality parameters.

What must be kept in mind when devising an approach for improving the participation of the private sector in Copernicus, is that business cases for privately-funded space infrastructure and services are actually stimulated by the existence of Copernicus data and public operational services. It is by ensuring the **continuity of high-quality Sentinel data** that we are going to foster the right environment for the development of complementary data sources and improved commercial products. Copernicus missions (the Sentinels) represent enablers for companion missions that can be much simplified in order to offer higher revisit or higher spatial resolution, in particular through the use of the Sentinels as references for cross-calibration of the new systems.

While sentinels offer irreplaceable very high-quality data, especially in terms of radiometry and spectral accuracy, they could adequately be **complemented by services offering high revisit and/or the spatial resolution** that could be provided by other public or commercial partners.

Indeed, highly responsive and local observations, whether independently scheduled or using Sentinels to trigger action, can be entrusted to private European actors to include, wherever possible, on-demand capacity alongside systematic acquisition schemes.

In any case, industry recommends that, regarding the capabilities provided to Copernicus by private European actors, the **long-term availability and the accessibility of the data are guaranteed** and that standards are being developed and applied in order to facilitate interoperability and to ensure a high level of quality, also as a protection for the worldwide reputation of the Copernicus "brand". Besides, developing those standards (and the certification process mentioned above) will be instrumental for Europe to maintain its leadership in this domain, and to improve the competitiveness of its EO industry.

Towards a Copernicus governmental service dedicated to a more resilient Europe?

First of all, it should be remembered that Copernicus already offers an Emergency Management Service, as well as services for "Border surveillance", "Maritime surveillance" and "Support to EU External Action". An assessment of the status, benefits, strengths and weaknesses of these services would certainly bring relevant recommendations, and **industry is fully prepared to support the definition and implementation of space and ground systems upgrades**, in order to meet potential needs still deemed unfulfilled by institutional users.

Copernicus Governmental services would require early notification and frameworks but also guaranteed European autonomy through, inter alia, mandatory use of European cloud, microservices, and applications as well as European Satellite data preferences.

An extension of Copernicus towards Security (in particular considering the "dual-use" scenario) capabilities **would mean a significant increase of the programme objectives** and should be carefully assessed, according of course to the (rapidly evolving) European security and defence policy requirements and ambitions, but also according to the funding capacities and to the limitations imposed by the current Copernicus data policy.

Industry identifies many direct and indirect opportunities (such as VHR imagery, near-real-time availability, increased use of AI) stemming from the development of a "governmental service" but insists that such a service shall not jeopardise the developments of the planned Sentinels, nor the continuity of the services.

If the EU and its Member States takes the decision to launch and finance such a "governmental service", industry anticipates the need for several new capabilities including:

- VHR imagery;
- Near Real Time availability;
- Increased use of AI to concentrate the information to the users' needs;
- Guaranteed and Secured access to data;
- Processes to ensure confidentiality regarding the taskings;
- Capability to inter-operate with national security dual-use missions;
- Flexible, reactive and reconfigurable operational profile for real-time crisis management.

Furthermore, these **new requirements can be synergetic with the secure connectivity constellation initiative**, in order to ensure the security and rapid availability of the data. Additionally, use of optical inter-satellite links could allow a secure data-relay through the connectivity constellation, and, more generally, ensure an efficient management of the enormous quantity of data generated by these future EO missions.

Such an evolution of the programme would allow industry to **leverage past investments** done in the frame of national security programmes and offer an **opportunity to open new markets**. Besides, it will allow industry to complement its products with subsystems coming from the whole European supply chain, while national programmes often focus on national supply chains.

Implications regarding the resilience and security of the Copernicus programme itself

Resilience and continuity are key aspects for users and the downstream industry. The first priority is of course to **secure the know-how and competencies of the European industry**, built over 20 years of experience, including throughout the whole supply chain.

Obviously, the more Copernicus would be used for security-related missions, the more stringent the security-requirements applicable to the programme will need to be. Copernicus would need a **secure design at several levels**: launch segment, space segment, ground segment, data and services production, data exploitation. Securing data thanks to Cloud architectures and top-notch cybersecurity measures and policies would also become a must to guarantee data availability and integrity, and it reinforces the necessity of a certification scheme (see above).

More generally, **strict eligibility and participation conditions** need to be defined to preserve the security, integrity and resilience of the Copernicus infrastructures and services.

From a governance point of view, the establishment of an Operational Security Authority component for Copernicus would also be required.

To guarantee resilience and security, the launch of the Copernicus satellites needs to be performed **by European launchers from European territory**. Launcher and satellite stakeholders in Europe need to work hand in hand to guarantee their compatibility.

Finally, as Copernicus (and the other EU space infrastructures) is becoming increasingly critical for Europe, its citizens and its businesses, the need for an **efficient and autonomous space situational awareness and space traffic management systems** are becoming more and more indispensable.