



# **IMPACT ASSESSMENT OF ESA EARTH OBSERVATION EARLY R&D ACTIVITIES**

**Sentinel-3 Next-Generation Land and Ocean Optical  
Imaging Architecture Study**

**know.space**

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## Anthropogenic impacts on Earth's environment are driving the need for EO satellite data ...

From the changing atmospheric composition to disrupted marine ecosystems, many of Earth's systems are changing, underpinned by a growing population, increasing economic activities, and climate change. For example, 46% of Europe's coastal waters significantly suffer from harmful algae and plant growth.<sup>1</sup> This has made understanding and responding to Earth's changing environment increasingly important.

Sustained accurate data of Earth's systems on a global scale is crucial for tackling these environmental challenges. This is the goal of Copernicus - the European Union's Earth Observation programme. Led by the European Commission (EC) in partnership with the European Space Agency (ESA), the programme consists of a series of Sentinel satellites that provide data for climate, marine, land and atmospheric monitoring, alongside forecasting services for disaster management. Studies estimate that Copernicus will generate between €67 billion and €131 billion in benefits for Europe between 2017 and 2035, with over 80% of these benefits being generated outside of the space sector, highlighting the value of the programme and importance in ensuring its continuity.

Figure 1: Sentinel-3



Source: ESA/ATG medialab

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<sup>1</sup> European Commission. (n.d.). *Marine environment*.

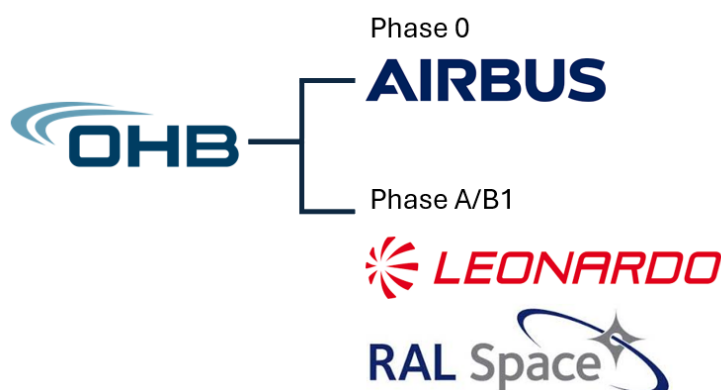
Sentinel-3 is a constellation of two satellites that operate in tandem to provide high quality data coverage of Earth. Sentinel-3A and Sentinel-3B (launched respectively in 2016 and 2018) each carry four instruments: an Ocean and Land Colour Instrument (OLCI), a Sea and Land Surface Temperature Radiometer (SLSTR), a Radar Altimeter (SRAL) and a Microwave Radiometer (MWR). Together, these instruments provide measurements on land, ocean and atmospheric compositions and cover a wide range of applications.

## ... while ESA is funding developments towards the next generation of Sentinel-3 ...

To ensure continuity of the Sentinel-3 mission and enhance performance, ESA is funding the development of Sentinel-3 Next Generation Optical (NGO) through the FutureEO programme. The satellite will carry the Advanced Ocean and Land Colour Instrument (AOLCI) and Advanced Sea and Land Surface Temperature Radiometer (ASLSTR). These instruments will improve Sentinel-3's current optical instruments: the AOLCI will have a spatial sampling distance (SSD) of 150m, which is twice as high as before, and will cover an increased number of spectral bands, while the SSD of the ASLSTR will be brought to 500m for all the spectral bands that it covers.

ESA has awarded contracts to two separate consortia, one led by OHB (DE) and another led by Thales Alenia Space (FR), with the goal that this will stimulate competition to foster innovation and optimise the quality of Sentinel-3 NGO instruments and mission design. The focus of this case study is the OHB-led consortium and its activities through phase 0 and phase A/B1. In the lifetime cycle of ESA missions, these phases are characterised by mission and system definition, concept trades, technology assessment and predevelopments, cost estimation and implementation planning.

Figure 2: Team diagram outlining the project prime and subcontractors of the project



Source: know.space based on ESA data

OHB was awarded a €700,000 contract in 2021 for phase 0 of the mission. With Airbus as a subcontractor, who was focused on the ASLSTR instrument, the consortium explored the preliminary set of mission requirements. This included the European Commission and the Sentinel-3 NGO Ad Hoc Expert Group (AHEG), who helped to identify the technological user needs balanced against cost drivers. OHB went on to secure a 2.5 year, €9.5m contract for phase A/B1 (including predevelopments) and is currently leading the consortium with Leonardo (IT) and RAL Space (UK) as subcontractors. OHB has been developing the mission design, satellite platform and AOLCI, with Leonardo largely responsible for the ASLSTR and RAL Space providing additional scientific expertise.

## ... which will ensure continuity of this robust European data source and associated societal benefits ...

The developments made in this project will support a smooth transition into mission phases B2/C/D, a roadmap towards launch in ~2036, and a successful mission overall. In turn, this will enable the continuity of high quality and readily available Sentinel-3 data to end users (see Annex A: Applications of Sentinel-3 NGO).

The longevity of EO data supported by this project provides end users with sustained insights on Earth's environment and global systems, benefitting the climate science community through the long-term modelling of trends such as atmospheric composition and sea ice movement. This is important for Europe, as the frequency of natural disasters such as flooding and wildfires is growing due to disrupted precipitation and wind patterns, increasing pressure for improved risk and disaster management to protect communities' wellbeing, infrastructure, and valuable ecosystems. Beyond minimising the negative impacts of these events on communities, it can help commercial actors and policymakers to plan efficient mitigation or adaptation strategies to minimise the broader social and economic impacts of climate change.

Another valuable application of Sentinel-3 NGO data will be water quality monitoring, as Europe's inland bodies of water are being degraded by pollution from cities, agriculture and other economic activity such as mining. It is estimated that 22% of Europe's surface water bodies significantly suffer from this pollution, leading to disrupted aquatic ecosystems.<sup>2</sup>

Several satellites have been designed to collect EO data for similar applications as Sentinel-3 NGO, such as the ocean colour sensors SeaWiFS (NASA), MODIS (NASA) and MERIS

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<sup>2</sup> European Environment Agency, 2021. *Pollution and barriers are key problems for Europe's waters.*

(ESA). However, unlike the Sentinel missions, these were one-off scientific missions - leaving a gap for the necessary provision of continuous long-term data. This project will help ensure that Sentinel missions, and the overall Copernicus programme, continue to generate data that will feed into trends and analyses beyond the satellites' operational lifetime, and into the long-term future.

## ... and deliver valuable socio-economic benefits.

Beyond the societal benefits that Sentinel-3 NGO will foster, this project is already producing a range of socio-economic benefits for OHB and the wider European space sector, including supporting a highly skilled workforce, strengthening collaborations, and enhancing European non-dependence.

### De-risking technological developments

The project is playing a critical role in mitigating risk for the Sentinel-3 NGO mission and ensuring the effective use of resources through the early assessment of mission requirements and feasibility studies.

During the phase 0 and phase A/B1 studies, OHB has explored existing technologies as well as designed new concepts to assess their feasibility for the mission. This includes the preliminary developments of a new detector for the AOLCI. These early-stage activities enable OHB to re-scope any perceived inefficiencies or performance challenges that may arise as the technologies undergo rigorous assessment, thus playing an important role in mitigating risk for the Sentinel-3 NGO mission. This results in reliable technology designs with a robust roadmap for developments in subsequent phases, ensuring that future Sentinel-3 NGO funding is used effectively and efficiently, and that the mission remains on schedule.

ESA's support further reduced risks in the early developments of Sentinel-3 NGO, with the Agency overseeing the project to ensure that the preliminary developments were moving in a direction that would satisfy user-defined requirements. During phase 0, such oversight helped refine the Mission Assumptions and Technical Requirements Document. This de-risked both OHB's developments and ESA's investment, ensuring that time and resources were being allocated towards technology that would work to meet user needs. The Agency continuously consulted experts to decide any specific technological aspects that would be necessary for meeting the desired performance levels of Sentinel-3 NGO, which were then built into the project as a key specification.

## Enabling and strengthening collaborations

The project has strengthened relationships between ESA experts and OHB, and deepened multi-national European collaborations in EO through the project's partners and subcontractors.

Through this project, OHB has been able to collaborate closely with experts at ESA, including on the topic of ground processing. This has helped ensure that developments made within the project are being guided by robust scientific and technical knowledge. Furthermore, this activity strengthens the long-term relationship between OHB and ESA, nurturing trust and familiarity between the stakeholders which can be leveraged for effective and efficient future collaborations. This relationship strengthening is especially evident in the coordination role that ESA is playing between the various actors. The Agency has gathered inputs from external stakeholders, allowing end-user expertise to be shared with OHB. This has helped guide the early-stage development of Sentinel-3 NGO, ensuring that end-user needs are effectively translated into a strong technological roadmap.

OHB also highlighted the importance of the collaboration with suppliers and subcontractors to achieve high quality project results. Its relationship with both Leonardo and RAL was strengthened through this activity, reinforcing cross-national industry collaboration within Europe. For example, RAL have been involved as experts on sea surface temperature, and have shared their expertise and capabilities in algorithms and simulations, supporting OHB's activities in Phase 0 and A/B1. This collaboration comes off the back of the 2023 renegotiation of the UK as an active member in the Copernicus programme, following their previous departure resulting from the UK's EU exit. While the UK has always remained a full Member State of ESA, this activity has been an opportunity for a UK stakeholder to re-engage with the Copernicus programme, playing an active role in an upcoming mission.

### Supporting a robust workforce

ESA funding is supporting ~35 jobs at OHB, demonstrating its role in retaining high-skilled talent in Europe's space sector and the field of Earth Observation.

Around 35 people at OHB are working on the preliminary developments of Sentinel-3 NGO, with several fully dedicated to the activity, supported entirely by ESA funding. A significant portion of the project team consists of systems engineers, demonstrating the retention of highly skilled personnel in the European space and EO sectors. This investment highlights ESA's role in sustaining strong engagement with space companies like OHB, ensuring the

continued involvement of high skilled professionals in critical missions, nurturing a strong talent pipeline for the industry.

For OHB, the project supports staff retention by providing team members with the opportunity to contribute to an exciting, motivating, and highly relevant mission. This is especially valuable for young professionals, as the project offers both excitement and a significant learning opportunity. If OHB secures the contract for the next phases of Sentinel-3 NGO, these benefits could expand significantly, with more staff joining the project to support the broader scope of the implementation phases.

### Upskilling the project team and young professionals

ESA funding is strengthening the European space sector's talent pool by enhancing the technical and problem-solving skills of the project team while giving early-career professionals valuable space mission experience.

The OHB project team consists of a mix of senior and junior members, with the latter making up around half of the team. ESA funding is therefore enabling young professionals to work on a high profile, cutting-edge project whilst providing them with early phase space mission experience. This equips these junior members with valuable skills, including a deepened understanding of ESA's early mission phases and the importance of rigorous technology assessments to de-risk larger technology developments. This project also strengthens skills in balancing technological feasibility, cost drivers and user requirements. The valuable 'hands on' experience is therefore helping increase young professionals' understanding of the robustness required for missions, both from a project management and technical perspective. This ultimately contributes to fostering a robust pipeline of highly skilled talent for the European space sector.

OHB highlighted that the entire team is continuously upskilling through this project, particularly in technical expertise, as they tackle the challenges of developing innovative technologies like the AOLCI detector. Creating cutting-edge instruments for such a complex mission demands innovative thinking and continuous skill adaptation, strengthening problem-solving abilities and deepening technical capabilities. Additionally, the project enhances knowledge of ESA processes and EO mission technology development, improving quality assurance to meet the stringent standards of space missions. An increasingly capable team can drive efficiency in OHB's future projects, including potential next phases of Sentinel-3 NGO if the contract is secured.

Additionally, ESA funding provided a valuable mechanism for knowledge sharing. The Sentinel-3 NGO Ad Hoc Expert Group (which includes NASA, the European Centre for

Medium-Range Weather Forecasts (ECMWF) and other organisations such as EUMETSAT) were involved in the early stages of the project to provide end user perspectives, which ESA shared with OHB. This helped increase the team's understanding of user needs, improving their knowledge of the end-to-end EO supply chain. Beyond being valuable for the possible Sentinel-3 NGO phase B2/C/D activities, this can be leveraged for future EO projects, helping make them more efficient and effective.

## Enhancing OHB's reputation and visibility

OHB's reputation as a leading space systems manufacturer is being maintained and strengthened through this project, given the high profile and wide user engagement associated with the Sentinel missions.

Although still in early development, Sentinel-3 NGO is already a high-profile mission with wide recognition. Its predecessor, Sentinel-3, sees an average of 3.2 million data product downloads per month, highlighting its broad user base and visibility.<sup>3</sup> As the follow-on mission, Sentinel-3 NGO is expected to achieve similar prominence. This visibility benefits OHB, reinforcing its reputation as a leading space systems manufacturer and showcasing its expertise in managing large-scale missions. Additionally, the project enhances OHB's profile, fostering new partnerships and collaboration opportunities while strengthening its competitiveness for future mission leadership roles.

The project offers a valuable opportunity to further strengthen OHB's reputation in the coming years. Sentinel-3 NGO phase B2/C/D will require large contracts for technological developments and qualification. If OHB secures these contracts, the decisions and designs made in phase 0 and phase A/B1 would dictate the mission's direction, and the company would be largely responsible for the mission's implementation phase, including the production and qualification of the satellite's components. This would position OHB as a trusted contractor in delivering complex missions while meeting stringent quality, budget, and timeline standards.

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<sup>3</sup> European Space Agency, n.d. *Sentinel Online: Sentinel-3*.



## Maintaining and strengthening European non-dependence

ESA funding ensures a reliable and resilient European EO data source, reducing dependence on external systems and minimising potential disruptions to services and research.

This project is laying the foundations for a future mission that will provide European end users with reliable and continuous access to essential EO data. ESA funding for the preliminary developments of Sentinel-3 NGO supports a robust roadmap towards a successful mission, which in turn, enables the return of high quality EO data.

While Europe's sharing agreements with other nations for access to EO data, such as with the United States' National Oceanic and Atmospheric Administration (NOAA), remain valuable, ensuring the availability of European-captured data is strategically important. This is because the data supports a wide range of critical infrastructure, such as forecasting systems and disaster response. This includes the Copernicus Emergency Management Service (EMS), which currently leverages Sentinel-3 data for important activities such as wildfire detection. Open access to EO data through a European source like Sentinel-3 NGO can increase its reliability and resilience, minimising the possibility of disruptions to both the critical services and scientific research that leverage the data.

### Supporting a wide range of products, services and scientific research

ESA funding is supporting the continuation of products including forecasting systems and geospatial platforms, alongside enabling enhanced scientific research on Earth's systems.

By developing robust foundations for the Sentinel-3 NGO mission, the project contributes to data continuity, which is essential to maintain and enhance the wide range of products and services that are already relying on the current Sentinel-3 mission. This includes commercial geospatial platforms such as ESRI's ArcGIS and Airbus' Sentinel Hub, which can be valuable for users in agriculture and urban planning.

The project is also supporting the continuation of scientific research that leverages Sentinel-3 data. For example, the enhanced performance of Sentinel-3 NGO, such as the increased number of spectral bands for the AOLCI, will provide higher quality data for diatom monitoring, which could be leveraged for better water quality assessments. The ASLSTR will provide continuous and higher quality data of sea surface temperature and improve the sensitivity of aerosol measurements. These will, in turn, enable scientists and researchers to make more accurate assessments of Earth's systems and improve the accuracy of models depicting changes over time. This is also critical for other actors, such as those in the fishing industry

for whom water conditions can play a large role in the success of their operations, and public health organisations who are interested in pollution levels.

## Would these benefits have been realised without ESA?

ESA support has been crucial for materialising many of the benefits discussed above. Funding these early mission phases of Sentinel-3 NGO is helping to lay a robust foundation for the subsequent phases where stakes are increased given the higher investments involved.

The Agency played a key coordinating role, providing a valuable platform for experts from various fields to contribute to the Sentinel-3 NGO mission requirements. This is essential for ensuring that ESA funding is used effectively to create technology roadmaps that align with end-user needs, enabling the mission to perform as intended.

*“Through this project we are learning a lot from ESA. Their expertise, along with the expertise of OHB, means we can work together to find the best route forward for mission developments.” – R. Guerrucci, OHB*

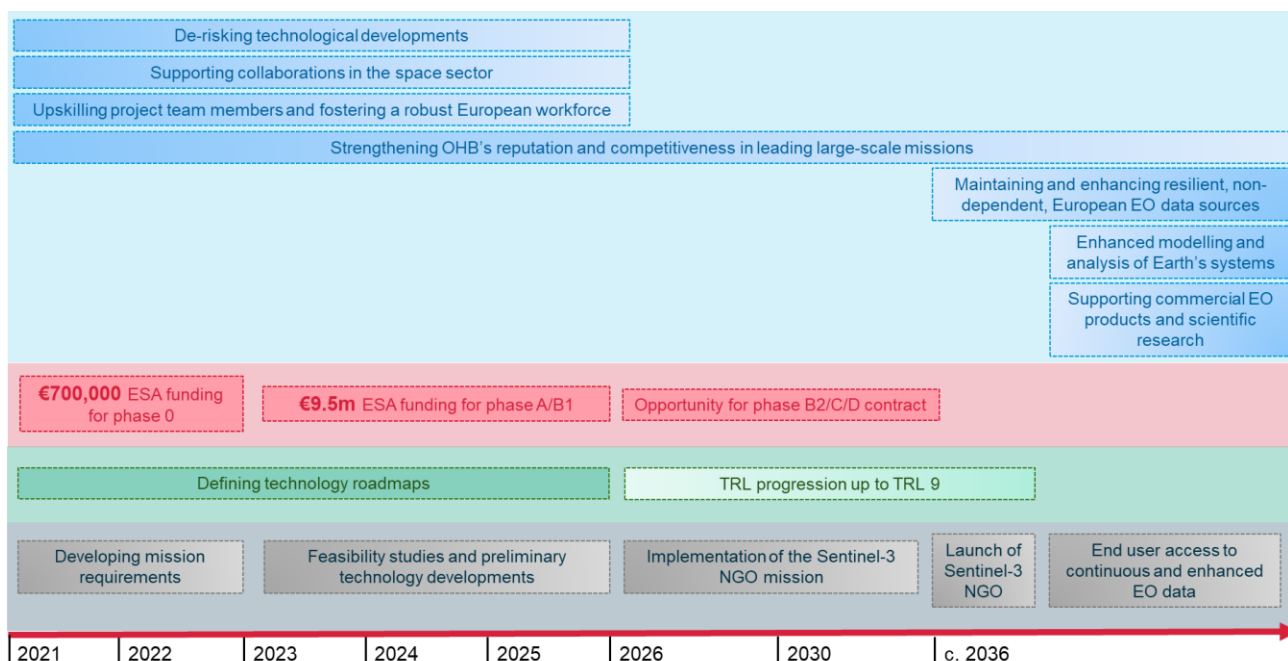
ESA expertise also played an important role in de-risking the preliminary developments made during this project through the provision of technical knowledge to the contractors. This was notably the case in ground-processing, allowing OHB to carry out developments with improved knowledge of how the data from Sentinel-3 NGO will be processed for end user products. This ensured that the technologies designed function in line with existing processing protocols.

## Next steps: Further development, further benefits

The next steps for this activity will involve the development of phases B2, C, and D of Sentinel-3 NGO, once a consortium is selected. This will mark the beginning of implementing the mission designs and technology roadmaps defined in phases 0 and A/B1, with expected significant benefits for the consortium. Contracts for the future mission phases would require a larger project team at OHB, scaling up the upskilling benefits currently being realised and further supporting OHB and Europe’s space workforce. Additionally, OHB has noted the potential for internal investments if they are awarded the next mission phases, ensuring that the organisation’s tools and infrastructure meet the demands of large-scale developments required for the implementation of Sentinel-3 NGO.

A preliminary timeline of the activity is provided below, including its possible follow-on phases, and the associated investments and benefits.

Figure 3: Overview of the timeline of the Sentinel-3 NGO phases 0 and A/B1 activities, potential subsequent phases, and the associated benefits



Source: know.space based on data from ESA and OHB

## Key priority indicators

Programme	FutureEO
Country	Germany, Italy, United Kingdom
Activity cost	€700,000 for phase 0, €9.5m for phase A/B1
Duration	2021-ongoing
Lead contractor	OHB (DE)
Sub-contractors	Airbus (Phase 0), Leonardo (IT) and RAL Space (UK)
TRL progression	-
Spin-in into the space sector	-
Jobs supported	~35 individuals at OHB
New collaboration with ESA	-
Partnerships strengthened	OHB-RAL Space, OHB-Leonardo
Follow-on funding applied/secured	Potential to secure ESA contracts for the next mission phases of Sentinel-3 NGO, possibly valued in the hundreds of millions of euros.

## Annex A: Applications of Sentinel-3 NGO

The following provides a summary of the applications for each instrument on Sentinel-3 NGO.

Table 1: AOLCI applications

Application	Significance
Land Use and Cover	Supports environmental and agricultural monitoring.
Land Surface Albedo	Measures solar radiation reflectance, aiding models of Earth's surface energy budget.
Vegetation Monitoring	Supports measures of vegetation productivity.
Ocean Net Primary Production	Estimates productivity of photosynthetic organisms, like phytoplankton, for biogeochemical research.
Algal Bloom Monitoring	Detects algal blooms for water quality monitoring and marine ecosystem management.
Sedimentary Process Monitoring	Monitors sediment transport for coastal management.
Atmospheric Composition	Measures aerosols in Earth's atmosphere, aiding weather forecasting and climate studies.
Illumination Condition	Measures natural light availability to monitor productivity of photosynthetic organisms.

Table 2: ALSTR applications

Application	Significance
Land Surface Temperature	Provides data for climate studies and helps in monitoring impacts on ecosystems and agriculture.
Fire Location and Detection	Detects and monitors fires, assessing their impacts on ecosystems, carbon emissions and atmospheric composition.
Vegetation Index	Monitors vegetation health, supporting applications such as desertification detection.
Sea surface Temperature	Provides data for marine science, climate modelling and marine biodiversity studies.
Sea Ice Monitoring	Monitoring sea-ice temperature for climate studies.
Aerosol Optical Depth	Measures aerosol concentration aiding understanding of energy balances in Earth's atmosphere.