ARTES 4.0 Generic Programme Line Business Applications - Space Solutions

# “Space for Construction Monitoring”

# THEMATIC CALL FOR PROPOSALS

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## Table of ACRONYMS

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|---|---|
| AI | Artificial Intelligence |
| APQ | Activity Pitch Questionnaire |
| AoF | Authorisation of Funding |
| ARTES | Advanced Research in Telecommunications Systems |
| BASS | Business Applications and Space Solutions |
| DG | Director General |
| ESA | European Space Agency |
| FP | Full Proposal |
| OP | Outline Proposal |
| OSIP | Open Space Innovation Platform |
| SME | Small and Medium sized Enterprise |
| TIA | Directorate of Telecommunications and Integrated Applications |

## 1. OVERVIEW

This document presents an overview of "Space for Construction Monitoring", thematic call for proposals issued under the ARTES BASS, 5G and 4S programme lines. The call offers the opportunity to companies to bring forward their business propositions, which leverage space and advanced digital technologies for the purposes stated below.

## 2. BACKGROUND AND RATIONALE

Construction progress monitoring involves tracking and assessing the development of a construction project over time to ensure that it aligns with planned schedules, quality standards, and budgetary constraints. It uses various tools and techniques, including on-site inspections, drone surveys, and digital solutions such as Building Information Modelling (BIM) and remote sensing technologies, to capture timely data and provide stakeholders with a clear overview of the project's status. This helps identify delays, issues, and risks early, facilitating timely interventions and ensuring efficient resource allocation and project completion.

However, current progress monitoring methods have room for improvement, especially regarding providing adequate visibility of large, disparate construction projects and assets across regions.

The state-of-the-art often involves the use of manually operated drones that are typically limited by constraints on coverage and pilot availability, resulting in infrequent inspections which provide limited site visibility in-between visits. Additionally, physical site visits are required by survey teams to gather more comprehensive data and plug information gaps. Visibility gaps persist nonetheless, and costs are driven up by associated operational expenses, on-site travel, and the time of those involved, not to mention normalising and utilising non-uniform datasets gathered from different sources at different times. Satellite data and technology offer a potential solution to fill said gaps, enabling improved visibility, reduced costs, and less need for on-site travel. For multi-national companies managing construction activities over multiple cities or countries, satellite data and technology offer the potential to enable greater coverage and more frequent updates than the current approaches used and scalability across multiple sites. Likewise, advances in complementary technologies such as machine learning, advanced data capture technologies, autonomous systems, and otherwise, offer avenues towards the same end.

The global construction market is expected to reach USD 19.52 trillion in 2027 at a compound annual growth rate (CAGR) of 6%, according to the Business Research Company. [1] The construction site monitoring market is estimated at a fraction of this at USD 2.11 Billion in 2024 and expected to reach USD 3.85 Billion by 2028. Growth is expected to be driven by demand for sophisticated monitoring solutions that enhance efficiency and productivity on construction sites, alongside a need for monitoring with

[1] Middle East Property and Construction Handbook 2022 - Global construction prospects 2024 (aecom.com)

higher temporal resolution. This is in view of enabling proactive decision-making and reducing risks associated with on-site activities. [2] As such, the opportunity for new solutions introducing a step-change to construction monitoring processes will be poised to exploit a large, growing, and global market opportunity.

## 3. OBJECTIVES OF THE CALL

The main objective of this thematic Call for Proposals is to assess the feasibility of, and/or demonstrate, high temporal and spatial resolution monitoring of construction projects using satellite data and technology, at a competitive price point. The activities will enable improved monitoring of construction sites and earthmoving activities. Additionally, this call invites proposals that explore the integration of satellite data with other data sources such as ground-based sensors, IoT devices, and aerial platforms to create a comprehensive, multi-layered monitoring solution, as far as is deemed beneficial to prospective users.

Examples of areas of interest are listed below.

### Progress Monitoring

A key area of interest is progress monitoring of construction site activities for the purpose of tracking project advancement from commencement through completion. Solutions should enable robust quality control through comparisons between design, pre-construction and as-built conditions, such that likeness to original plans can be evaluated and scrutinised. Tracking progress of on-site activities over time enables stakeholders to ensure (and evidence) alignment with agreed upon schedules and identify key issues underpinning delays and associated cost impacts. To achieve this end, monitoring capabilities should cover parameters such as distances, areas, volumes, elevations and cut/fill quantities. Across multiple sites, it is essential to normalise and streamline reporting of said data, and ultimately enable accurate and detailed oversight of the progress of construction projects to deliver on time and budget. There is also interest in exploring predictive analytics and AI-based forecasting models to anticipate potential delays or issues before they arise, allowing for proactive measures and optimised resource allocation. Integrating these monitoring capabilities with project management tools and enabling automated alerts of issues is also expected to simplify the work of those managing sites across regions.

### Safety Monitoring

Safety monitoring in construction is key to ensuring a safe work environment for on-site personnel and the surrounding public. There are also serious ramifications for breaches of occupational safety and health regulations, incentivising stakeholders to implement judicious safety measures. A high degree of safety is not trivial to achieve, however, due to constantly changing conditions, movements, and interactions among workers,

[2] Construction Site Monitoring System Market Overview: Market Size, Major Drivers And Trends - Latest Global Market Insights (tbrc.info)

machinery, and equipment, which can give rise to a broad range of safety incidents on the construction site. Additionally, worksite hazards vary, spanning risks from working at height, moving of heavy equipment, electrical exposure, toxic substances (such as asbestos), dust exposure (from processing of construction materials or the surrounding environment), collapse of trenches and excavation-related incidents, noise exposure, and general falls, slips and trips. [3]

Various safety protocols are enforced to prevent accidents and maintain compliance with applicable regulations. To enable this, efforts are put towards early hazard identification on the jobsite such as unsafe scaffolding, exposed wiring, adverse weather conditions, or heavy machinery operating in dangerous conditions. The latter concerns avoidance of machine-to-people, machine-to-machine and machine-to-object collisions by increasing machine operators' visibility and awareness of risks. Moreover, there is interest in solutions that incorporate the use of satellite technology and data for regularly updated safety assessments, including appropriate positioning of safety equipment (e.g. traffic barrels), environmental risk factors such as heat stress, air quality, and flood or landslide risks. Use and integration of building information modelling and techniques such as computer vision offer a path towards improving safety through 3D representations of jobsites combined with high frequency updates, such that stakeholders maintain an up-to-date view of hazards as they manifest. Satellite data may also be used to monitor and predict the impact of weather conditions (such as storms, heavy rain, or extreme temperature) on construction site activities and timelines.

**Structural Monitoring**

Structural monitoring enables the assessment and tracking of the condition of civil infrastructures over time to ensure their safety, stability, and longevity. Using both manual and automated methods, key parameters such as displacement, deformation, settlement, tilt, load response, and others pertaining to the infrastructure are measured, covering both static and dynamic monitoring. The early detection of potential issues like ground settlement or structural deformation allows for timely interventions, reducing the risk of accidents and extending the life of the structure. Additionally, it helps minimise costs by avoiding expensive emergency repairs and mitigating legal and financial risks. Robust traceability of infrastructure health data is imperative in post-incident analysis of structural failures and ensuring associated accountability.

Opportunities exist for better exploitation of predictive maintenance capabilities, combining satellite imagery with historical data and ML algorithms to predict when and where structural issues are likely to arise. Advances in Deep Learning algorithms applied to UAV-derived imagery have enabled automated identification and characterisation of structural defects from cracks through deformation and mould. Additionally, 3D imaging technology (through LiDAR, photogrammetry…) is an expanding field being explored to produce more detailed imaging of buildings enabling the detection of more nuanced and subtle damage, deformation and stresses, unobtainable through 2D imaging alone. [4]

[3] A Simple Guide to Construction Safety SafetyCulture

[4] 3D imaging technology is a crucial tool for engineers | thestructuralengineer.info

### Documentation and Reporting Monitoring

Large infrastructure projects can be vast in terms of physical resources (labour, equipment, materials, components) but also digital resources, with an average project transacting millions of emails, documents and workflows. As such, large quantities of data are produced, with the majority going unexploited. Improved management of said documentation and reporting is expected to unlock efficiency (and accountability) gains for stakeholders of the construction sector. Challenges to attaining this goal include fragmented and siloed dataset repositories, data quality and consistency, interoperability of software applications used, security and privacy concerns, and integration of heterogeneous sources. [5] Automation of such processes, and extraction of key metrics, could free up the time of workers to focus on more meaningful, critical tasks to project execution, while increasing the quality and veracity of the data recorded and reported.

### Environmental Monitoring

The construction sector is responsible for a large proportion of waste and greenhouse gas emissions produced worldwide. Much of this is attributed to the operational phase of given infrastructure. However, a reasonable proportion of waste and embodied emissions produced in the construction lifecycle are thought to arise from the construction process itself. Systematic observation, measurement and analysis of environmental conditions on and around construction sites is critical to ensuring compliance with environmental regulations and maintaining positive reputational standing with local communities. Parameters of interest include noise levels, dust, air quality, VOCs (Volatile Organic Compounds), and wind speed and direction. Maintaining safe and acceptable levels of sustainability measures such as these is key for compliance but also reducing the risk of delays due to enforced work stoppages, and protection against claims. Advanced sensing equipment combined with geo-referencing and timestamping can help pinpoint sources of such issues enabling stakeholders to respond rapidly. [6]

### Logistics and Supply Chain Monitoring

Supply chain monitoring plays an important role in construction, ensuring that the needed materials, equipment and broader resources are acquired and delivered on time, in the right amounts, and at the right quality. To achieve this, services must track the entire procurement and delivery process, from sourcing materials through logistics management and supplier coordination. Macroeconomic events such as the COVID-19 pandemic, industrial actions (such as strikes in key domains, such as Ports), natural disasters, and political activity can influence on-going projects via supply chain disruption, alongside more localised issues facing suppliers. [7] Downstream impacts can span project delays, budget overspend, and even material damage. [8] Opportunities to improve such processes

[5] Data Management in Construction; 2024 Ultimate Guide - Neuroject

[6] Why the construction industry needs environmental monitoring | CTS

[7] Will construction supply disruption continue? | Journals | RICS

[8] Data centres maintain demand despite supply issues | Journals | RICS

lie in use of advanced tracking systems leveraging precision GNSS, IoT sensing and beyond, to provide real-time visibility into status and location of materials and equipment being sourced. Use of distributed ledger technology for improved traceability and transparency, alongside predictive analytics for risk forecasting in relation to supply chain issues, are further avenues through which to innovate. Use of these to optimise for just-in-time deliveries may also enable efficiency gains by negating the need for excessive on-site storage and minimising associated costs.

**Cross-Sector Services**

Cross sector services are also highly demanded, including services in which construction monitoring can be linked to broader infrastructure management (e.g. transportation network, utilities, and urban planning). Thus, allowing for more holistic solutions that consider not only the construction site but also its interactions with nearby infrastructure and ecosystems (e.g. to avoid disruption to traffic flow, utilities provision, and otherwise).

**Partner Use-Cases**

The initiative is supported by ESA partners from the infrastructure operations sector. Such partners have provided specific operational challenges within the domain of construction monitoring that they are seeking solutions for. These challenges are enclosed in the Annex to this document, as optional use-cases for Bidders to address.

The Bidder can also propose alternative use-cases/services within the overarching theme of construction monitoring provided that they are supported by relevant users and customers.

## 4. SPACE ASSETS

Satellite data and technology is expected to play a critical role in the proposed solutions to this challenge.

**Satellite Earth Observation (SatEO):** Satellite Earth observation data offers extensive coverage, frequent revisit rates, and consistent data quality across construction sites. Very high-resolution optical imagery (sub-metre) combined with complementary data can enable tracking of highway works, vegetation information, presence of land equipment, detection of vehicles, and like-for-like comparisons over time. Satellite radar data may support in identification of metallic objects on-site, area occupation, and otherwise, also enabling monitoring under any weather conditions. Earth observation can measure heat signatures, provide topographical measurements, air quality analysis and detect changes in land use.

**Global Navigation Satellite Systems (GNSS):** Remote sensing solutions may benefit from calibration and/or validation through periodic (though less frequent than current) site inspections utilising drones and similar technologies, utilising satellite positioning to geo-

/time-stamp information collected. Positioning data derived from equipment on-site is crucial in enabling comprehensive monitoring of activities on construction sites. GNSS receivers are a key component of structural integrity monitoring systems as well.

**Satellite Communication (SatCom):** SatCom may support drone operations in remote regions, when used to gather data to calibrate and/or validate remote sensing solutions used for the primary monitoring of construction site progress. Likewise, it may be used to enable IoT-based (Internet of Things) monitoring for the same purpose. More generally, SatCom can provide connectivity for remote sites that lack alternative communications means.

In all cases, the role of space technology and/or data in the service should be justified in comparison to non-space alternatives.

## 5. SCOPE OF THE CALL

The proposals submitted under this Call for Proposals shall address the construction and infrastructure domain with innovative user-driven downstream services which rely on satellite technology/data.

The Bidder shall either address the (optional) use cases included in the Annexes (published as a separate document) or address other use cases and requirements related to construction monitoring provided by other customers / users directly involved by the Bidder. In the latter case, support of those potential customers shall be evidenced in letters of interest to be attached to the Outline Proposal (the second step in the application process). Proposals under both options will be considered equally.

The service provider shall be identified and be part of the bidding team to ensure the commercial operational roll-out of the proposed service following completion of a demonstration project.

This Call for Proposals covers two types of activities:

1. **Feasibility Studies**, which provide the preparatory framework to identify, analyse and define new potentially sustainable services. The applications and/or services covered by the proposed Feasibility Studies must:
    - Be customer/user driven and present a strong sustainability potential.
    - Propose a service demonstrating the benefits of the utilisation of integrated space assets.
    - Include a viability analysis.
    - Aim to evolve the targeted applications and services to marketability and operational roll-out, potentially through a Demonstration Project after successful completion of the feasibility study.

2. **Demonstration Projects**, dedicated to the implementation and demonstration of pre-operational services. The applications and/or services covered by the proposed Demonstration Projects must:
    - Be customer/user driven (including user involvement and active participation in

the project).

- Propose a service demonstrating the benefits from the utilisation of space assets with clear potential to become commercially sustainable.
- Provide a measurable socio-economic impact.
- The Bidder shall involve in the project representatives from user communities, which shall take part in the pilot.

## 6. PROCUREMENT APPROACH

The proposals submitted in reply to the call shall be implemented in the context of ESA BASS, 5G and 4S programme lines of ARTES in coordination with National Delegations.

The Bidder shall submit first an Activity Pitch Questionnaire, and following evaluation, may be invited to submit the Outline and Full Proposal. The Activity Pitch Questionnaire (APQ) template provided by ESA shall be used. This is considered the entry point for companies to submit their idea, providing a simplified and single point of access to the ESA ARTES framework.

The price of activities carried out in a given State are charged against the contribution of that State in the programme. A letter of Authorisation of Funding (AoF) from the relevant National Delegation is therefore required as part of the Full Proposal submission. The Bidder is however advised to inform the relevant National Delegation(s) when submitting the Pitch, and subsequently apply for the AoF through their process. The contact information of the National Delegates can be found here: National Delegations | ESA Space Solutions

The Agency will admit for evaluation only proposals from a bidding team composed of a company and/or organisation - be it as Prime or Subcontractor - residing in any of those states that subscribe to the Programme under which you wish to submit your proposal:

I. **for the ARTES 4.0 BASS Generic Programme Line - Component A**: Business Applications. To date, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Sweden, Switzerland and the United Kingdom have subscribed.
II. **for the ARTES 4.0 5G Strategic Programme Line**: Austria, Belgium, Finland, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Portugal, Romania, Spain, Sweden, Switzerland, the United Kingdom and Canada have subscribed.
III. **for the ARTES 4.0 4S Strategic Programme Line:** Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, The Netherlands, Norway, Poland, Portugal, Romania, Spain, Switzerland, the United Kingdom and Canada have subscribed.

## 7. PROCESS AND SCHEDULE

It is planned for the call for proposals to be opened on 18th November 2024 until 18th February 2024, 13:00 CET.

### 7.1. Timeline and Procedure

Bidders can respond to this thematic call by submission of a short Activity Pitch Questionnaire within the above timeframe.

The Call is planned to be implemented according to the following stepwise approach:

In **Step 1**, the interested Bidders are requested to submit their proposal(s) based on a short Activity Pitch Questionnaire (APQ) template made available by ESA that can be downloaded from the Thematic Call website or found here. The pitch should provide the initial idea of what the Bidder would like to propose, elaborated based on the thematic areas, and either the use-cases proposed by ESA's partners or others selected by the Bidder. If the Bidder has the relevant information available to them, they may consider completing the supplementary questions (AP5) in the APQ template as part of the APQ+, which may allow to skip Step 3 below, at ESA's discretion.

The bidder should select 'Thematic Call (under 1-10494)' and 'Space for Construction Monitoring' under the drop-down options on the introductory page of the APQ template (also indicating if they intend to address an optional use-case or not) as per figure 1 below. **Should the bidder wish to cooperate with any of the listed partners in the annexes, they shall give to the Agency the authorisation to distribute the Activity Pitch Questionnaire to these stakeholders by explicitly stating it in the Activity Pitch Questionnaire**. Subject to such authorisation, the Agency will distribute the APQ to the bidder's authorised stakeholder(s) and liaise with them to facilitate interactions with the Bidder.

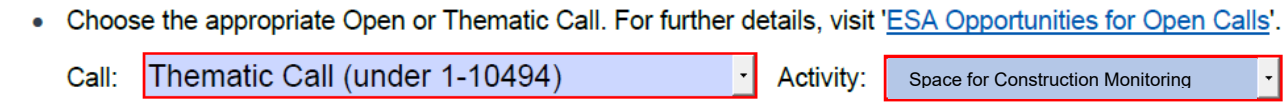



*Figure 1 Select 'Thematic Call (under 1-10494)' followed by 'Space for Construction Monitoring'*

The Bidder shall not contact any of the stakeholders listed in the annexes on the webpage.

**The Bidder shall NOT involve any of the stakeholders mentioned in the annexes in the bidding consortium neither as subcontractor nor as external service (including consultancy).**

The completed Activity Pitch Questionnaire (APQ) shall be uploaded using the online web submitter, ESA's Open Space Innovation Platform (OSIP) in the channel named "APQ for ARTES Downstream Business Applications"

Multiple Pitches can be submitted.

It is strongly recommended that the interested Bidder liaises with the relevant ESA Member State's Delegates from the beginning of the process.

In **Step 2**, following an assessment of the Pitch by ESA, ESA will provide feedback to the company, aiming to provide a reply within 10 working days following submission of the pitch. It is recognised that some interactions with the Bidder may be required, and ESA may therefore consult with the Bidder and may offer support in providing further clarifications, aimed at better shaping the subsequent proposal(s) in the steps that follow. Dialogue sessions may be organised individually with potential partners prior to Step 3. ESA might also consult, when necessary, with the relevant National Delegation(s) for orientation and will provide key information (e.g. title, cost, price, subcontractor) to the relevant National Delegation(s).

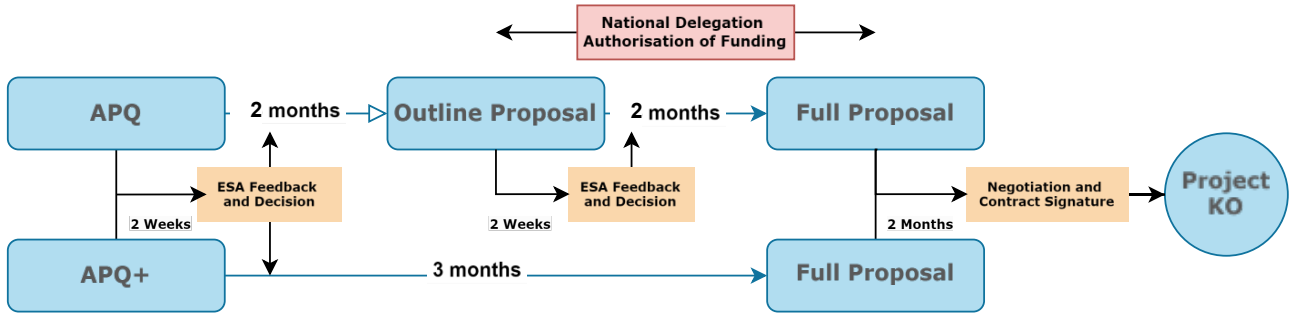
Subject to a positive evaluation of the Pitch and the Bidder having informed the National Delegation(s), the Bidder will be notified by ESA and invited to submit an Outline Proposal. Note that the APQ+ can act as a substitute for the Outline Proposal, thus if having adequately answered the additional questions included in the APQ+, the Bidder may be able to skip Step 3.

In **Step 3**, the Bidder will submit the Outline Proposal, based on a template provided by ESA, with letter(s) of interest from users/stakeholders. The Outline Proposal expands upon the Pitch with further detail. The Bidder will be allowed 2 months from the APQ submission approval to submission of their Outline Proposal. The Outline Proposal will be submitted on the OSIP platform under the channel "Outline Proposal for ARTES Downstream Business Applications – Feasibility Studies/Demonstration Projects".

In **Step 4**, subject to a positive assessment from ESA and in-principle support from the National Delegations, the Bidder will be invited to submit a Full Proposal on ESA-STAR in accordance with BASS programme line. The Bidder will be allowed 2 months from submission of their Outline Proposal to submit their Full Proposal on ESA-STAR.

In **Step 5**, the Bidder will submit a Full Proposal with the Authorisation of Funding (AoF) from the relevant National Delegation(s). Following a positive assessment by ESA the proposed activity will be approved for implementation.

A summary of the process is shown below.




***NB: Indicative Timelines are the Maximum Durations***

*Figure 2 Summary of the Application Process*

## 7.2. Evaluation Criteria

The evaluation process is non-competitive, as each proposal will be assessed individually on its own merits, according to the evaluation criteria applicable for CALL FOR PROPOSALS FOR DOWNSTREAM APPLICATIONS IN ARTES 4.0 (esa star ref.: 1-10494).

More information for the assessment of the APQ and outline proposal stages can be found on the OSIP page "APQ for ARTES Downstream Business Applications".

More information on the evaluation criteria for the final proposals can be found within the document "Appendix 1 to AO/1-10494/20/NL/CLP (Issue 2.2)" which can be found on ESA-STAR at the prior link.

# 8. GENERAL CONDITIONS

The submissions and all correspondence relating to it shall be in English. The tender shall not contain any Classified Information, whether in the Pitch, Outline Proposal or in the Full Proposal. To avoid any confusion with Classified security markings, the unclassified protective marking used by the Tenderer in the proposal shall not contain the terms: "Restricted", "Confidential", or "Secret".

However, should the Tenderer consider necessary to include Classified Information in the tender, the Tenderer shall inform beforehand the ESA Security Officer. The Tenderers are informed that Classified Information can be shared with ESA only in compliance with the Project Security Instruction (PSI) duly established by the Agency beforehand and subject to the approval by the ESA Member States.

The Agency will treat commercially sensitive or proprietary information confidentially and solely for the purpose of the assessment of the response. Expenses incurred in the preparation and dispatch of the response to the announcement will not be reimbursed. This includes any expenses connected with a potential dialogue phase. The announcement does not bind the Agency in any way to place a contract. The Agency

reserves the right to issue amendments to the announcement.