**ANNOUNCEMENT OF OPPORTUNITY IN THE FRAMEWORK OF ESA'S SPACE SYSTEMS FOR SAFETY & SECURITY (4S)**

**"SPACE SYSTEMS FOR SECURE COMMUNICATIONS"**

**TECHNOLOGIES, PRODUCTS, SYSTEMS AND END-TO-END INFRASTRUCTURES DEVELOPMENTS FOR SECURE COMMUNICATIONS**

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# 1. INTRODUCTION

## 1.1. Scope of the document

This document is the **Announcement of Opportunity for technologies, products, systems and end-to end infrastructure developments for secure communications** initiated in the frame of the ESA ARTES Space Systems for Safety and Security (4S) Strategic Programme Line.

The document is structured as follows:

— section 2 covers the background and rationale of this announcement of opportunity

— section 3 lists the domains of the announcement

— section 4 describes the process and the timeline related to a proposal submission

## 1.2. Reference Documents/websites

ARTES Programme: https://artes.esa.int

ARTES 4S Strategic Programme Line : https://artes.esa.int/safety-and-security-4s

ARTES Templates available here: https://artes.esa.int/documents

ARTES National delegations contact point: https://artes.esa.int/national-delegations

[PP]    Template of Pitch Proposal (embedded in the PDF document)

## 1.3. Acronyms

| | |
|---|---|
| AO | Announcement of Opportunity |
| ADS-B | Automatic Dependent Surveillance – Broadcast mode |
| AIS | Automatic Identification System |
| ARTES | Advanced Research in Telecommunications Systems |
| C&G | Competitiveness and Growth |
| DDoS | Distributed Denial of Service (attack) |
| ESA | European Space Agency |
| EU | European Union |
| EM | Engineering Model |
| EQM | Engineering and Qualification Model |
| GPL | Generic Programme Line |
| GS | Ground Segment |
| IoT | Internet of Things |
| IOT | In-Orbit Testing |
| IOV | In-Orbit Validation |
| IP | Internet Protocol |
| M2M | Machine to Machine |
| MOC | Mission Operations Centre |
| NGSO | Non-Geostationary Earth Orbit |
| RF | Radio Frequency |
| RPAS | Remotely Piloted Aerial System |
| SCC | Spacecraft Control Centre |
| S/C | Spacecraft |
| SPL | Strategic Programme Line |
| SOTM | Satcom On-The-Move |
| SWAP | Size, Weight And Power |
| TRL | Technology Readiness Level |
| UAV | Unmanned Aeronautical Vehicle |
| VDES | VHF Data Exchange System |
| VHTS | Very High Throughput Satellite(s) |
| 4S | Space Systems for Safety and Security |
| 5G | Fifth generation technology standard for broadband cellular networks |

# 2. BACKGROUND AND RATIONALE

## 2.1. State of Play

Our society, economy, security and sovereignty are increasingly depending on digital infrastructure and more specifically on communication networks. Any lack of coverage in some areas or loss of availability due to accidental or intentional disruption may have widespread impact and very negative consequences.

Hence, specific governmental attention is granted to communication services and networks required for essential governmental or institutional services (at national, regional or local levels). Additionally, focus is also on supporting operations deemed critical in fields as various as transport, finance, health, energy production and distribution, etc.. Security and appropriate control of their design, manufacturing and operations are indeed key requirements in support to resilience and sovereignty.

Governmental actions include setting pro-active public policies, imposing strict regulations on these services and the infrastructure that support them and carefully checking their application through various mechanisms such as service certification or operational oversight by dedicated governmental bodies or agencies. When necessary, they may also include direct procurement of infrastructure responding to their specific requirements, or support for instance through co-investment to public private partnerships in charge of deploying these infrastructures and providing the expected services.

Today, communications rely mostly on terrestrial network solutions that tend to be more and more integrated (IP, 5G, …), which may strongly increase the impact of any disruption. Furthermore, the decrease of the overall presence of Europe and Canada in the design and manufacturing of these terrestrial network solutions can negatively impact the actual level of control by European and Canadian authorities and institutions on telecommunications infrastructures, leading to serious implications on Europe and Canada safety, security and sovereignty.

In that context, it is growingly perceived that adding appropriately tailored secure Next Generation Satellite communications components to telecommunication infrastructures may greatly help to increase their overall resilience to any kind of disruptions, bring additional

capacity and ensure global coverage, while providing a stand-alone highly secure space-based capacity to channel the most sensitive and critical communications services.

## 2.2. Space Systems for Safety and Security (4S) Strategic Programme Line

In 2019, ESA Member States decided to create the Strategic Programme Line (SPL) named "Space Systems for Safety and Security (4S)" under the ESA ARTES programme for Telecommunication (Advanced Research in Telecommunications Systems). The objectives of the 4S Strategic Programme Line are to support the development of Next Generation Satcom Systems aimed at **providing secure and safe communications solutions** for governmental/institutional and public regulated services and ensuring resilience to society's critical digital infrastructures. Broadband connectivity as well as low data rate (ADS-B, AIS/VDES, IoT…) applications are considered. These entails the following applications areas, as shown in the figure hereafter (the applications areas presented are non-exhaustive).



A set of critical developments have been already identified in the framework of the ARTES 4S Next Generation satcom system studies as well as by industry and operators in the frame of ongoing 4S-related activities. They include critical technologies, products, and systems as well as the gaps to be filled by ESA Member States' industry to gain competitiveness in the satcom secure market and their timely availability to address near-term opportunities. Those are presented in chapter 3.

The availability of such solutions will not only unlock the implementation of strategic secure initiatives at national and EU level, but also will result in **commercial return for Industry** due the number of opportunities in this domain worldwide. These solutions can also enable new products to be spin-off into the commercial market and thus increase ESA Member States' competitiveness and share.

### 2.3. Announcement of Opportunity

The Industry is invited to submit a proposal in relation with 4S.

**This Announcement of Opportunity is open to Industry within ESA Member States participating in the 4S Strategic Programme Line**, namely: Austria (AT), Belgium (BE), Canada (CA), Czech Republic (CZ), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Romania (RO), Spain (ES), Switzerland (CH), and the United Kingdom (UK).

As it is key to have promising ideas being rewarded quickly, **ESA commits to have a fast review of proposals**. Section 4 shows the timeline associated to the submission of a proposal.

## 2.4. Co-funding scheme

ESA will co-fund the activity on behalf of its Member States. The maximum amount of co-funding will depend on the phases of the activity, its Technology Readiness Level (TRL) and structure of the Industry, as well as on the relevant Delegation's decision. Section 4.8 describes the maximum co-funding amounts in more detail.

Beyond financial co-funding, ESA will also bring its own experts together to critically assess the solutions and the technical activities performed as well as the business case presented during reviews.

In return, the Industry shall provide the respected private co-funding part and develop the solution/product/technology presented to ESA.

At the end of the activity, the Industry will own a (or several) product(s) it can capitalise upon and introduce it to the market.

# 3. DOMAINS OF THE ANNOUNCEMENT

The present Announcement of Opportunity aims to foster the development of 4S technologies, products, sub-systems, systems, end-to-end infrastructure solutions, upon which these Next Generation Satcom systems will rely.

Many activities describe the need for "secure" products and services. This encompasses **confidentiality** (e.g., through encryption, anonymization of users, etc.), **availability** (e.g., for high-reliability or safety of life applications) and **resilience** (e.g., by offering the same service transparently through independent network solutions).

As illustrations among many others, some ongoing trends, and objectives of growing importance:

— Developing solutions addressing the emergence of a growing governmental users' appetite for **low latency communication services** such as non-geostationary (NGSO) solutions,

— Evolving regulatory context and start design of solutions for **Railway Traffic Management**, **Air Traffic Management**, UAV/RPAS, etc. that rely on space assets and data;

— Enhancing **cybersecurity**, through the creation of frameworks and implementation of existing best practises;

ESA does not intend to prioritise any element of the above 4S activities. ESA expects the industry to define its own priorities (for instance in line with its internal strategy plans). For the same reason, ESA does not intend to prioritise particular domains of innovation in technology, product and service development. Consequently, this Announcement of Opportunity provides the **opportunity for industry to propose an implementation in response to its own priorities** regarding the different activity areas and the theme as a whole. These priorities can be further consolidated during the dialogue phase defined under section 4.1.

Furthermore, the Industry is encouraged to identify any value that the proposed activity may bring for reducing the dependency of institutional safety & security solutions on non-EU actors or actors outside ESA Member States, such as:

— ownership of asset, location of operations facility (e.g., S/C; SCC; MOC);

— security of technology supply, manufacturing know-how; and

— security certification.

The following sections provide an outlook of the critical 4S technologies, products, sub-systems, systems and end-to-end infrastructures. The list is not exhaustive, and the call opens to additional and complementary developments to the ones here below provided.

## 3.1. System

System-level developments are related to the overall optimization of constellations, the creation of tools and methods to improve performance or allow the design of new products. The creation of end-to-end services by this AO and products is covered in section 3.4.

Common high-level objectives in the industry, with some examples of associated technological developments are, at system level:

- Improved resource allocation and network management functions:

  o Dynamic Resource Allocation, and the management of service provision and priorities in case of contention,

  o Antenna diversity solutions, RF and IF coordination and frequency reuse,

  o Network orchestration and solutions for end-to-end performance optimisation/network routing optimisation

- Building blocks for an improved user and customer experience

  o Satcom resources digitalisation and pooling & sharing,

  o Easy and automated onboarding new assets/users to the system,

- Functions and methods for high-availability and resilience

  o Technical building blocks for high availability service (for example maintaining connectivity to more than one satellite),

  o Digital twin of the system – performance tweaking and offline fault investigation,

  o Other security and resilience features, see section 3.5,

  o Managing services across several space assets in different orbits, especially NGSO.

## 3.2. Space Segment

The space segment is the key aspect of satellite communication products and services. The developments covered under this section largely cover new features for communication payloads, but also improvement to the satellite platforms that widen the palette of options for satellite operators.

To enable the next generation of satcom services, the space segment will need development along at least three main axes:

- Creating or maintaining Europe's competitive edge in payload and platform hardware, especially thanks to more flexible and modular solutions

  o Dense functional integration, modularity, scalability, genericity and high in-orbit payload flexibility. Rapid service reconfiguration to place capacity in different geographical areas according to demand (e.g., disaster recovery)

  o Digitisation, including reconfigurable and regenerative signal processing, packet routing and beam hopping capabilities

  o Active antennas, photonics, microwave photonic and laser communication subsystems

- Embedding the latest techniques in satellite operations in the platform processing systems and procedures, and improve security

  o Autonomous or semi-autonomous in-orbit operations (e.g., exploiting artificial intelligence techniques)

  o Improved security and resilience in all aspects of the space segment (operations, segmented computing, interference management). See section 3.5.

- Enable novel and advanced use cases thanks to new capacities on board the satellites

  o Inter-satellite links, including links between constellations in different orbits in a "system of systems" scenario

## 3.3. Ground and user segments

The Ground Segment (GS) has become a key enabler of any emerging satcom systems, and for constellations. The availability of low-cost user terminals, a self-scanning antenna and automated and scalable Ground Segment architecture are examples of fundamental items required for the success of any satcom service and system deployment, for instance related to VHTS, M2M/IoT, constellation, SOTM etc.

At user segment level, developments towards the following objectives are required:

- Reducing production costs
    - o Mass manufacturable flat panel antennas
    - o Low-cost integrated terminals
- Accessing new space segments
    - o Orbit agnostic tracking antenna
    - o Multi-band antennas and terminals
- Ruggedizing and enabling novel applications
    - o Miniaturization, adaptation to user constraints (SWAP) of existing solutions
    - o Ruggedization of terminals
    - o Self-powered IoT, low power wearables

At ground segment level, developments in the following domains are required:

- Secured GaaS concepts and services,
- Cyber-secure Cloudification and Virtualisation of common ground segment functions,
- Digitalisation (e.g., of the RF chains)
- Seamless interface with terrestrial networks (e.g., 5G).

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## 3.4. End-to-End Products and Infrastructures

This section addresses the (emerging) end-to-end safety critical applications (e.g. for Aero, Maritime, Railway, connected land vehicles, utilities management, emergency, etc.). The development of tools and processes that allow the development of such solutions at system level is covered in section 3.2.

Related activities will target the definition, development, and demonstration of end-to-end infrastructure (space, ground and user segments). The infrastructure might adopt a set of technology innovations as described but not limited to the ones identified in the above sections.

Demonstration activities will include the demonstration of the innovative elements of the end-to-end infrastructure in the relevant operational environment to show to the end users the benefits of the proposed solutions.

## 3.5. Security

Security is a major element of Next Generation Satcom Systems. Innovation is anticipated both:

- For the communications infrastructure and protocols:
    - Technologies and standards for secure communications and networks (e.g. DDoS protection for inter-satellite links)
    - Institutional and commercial traffic secure virtual separation architecture
    - Cryptographic processing (quantum and non-quantum) and key distribution/management, both for the ground and space segment
    - Interference/jamming localisation and management, both on-board the space segment and for the ground segment (gateways and user terminals)
- For the supply chain and support systems:
    - Technologies and standards for secure space systems operations
    - Secure/Cyber-secure Cloudification/Virtualisation (ground and space segment)

Test bed for simulating attacks on space systems / cyber range

# 4. PROCESS AND TIMELINE

## 4.1. Timeline and procedure

Following a first and second issue of this opportunity from June to November 2021 and from December 2021 to May 2022, a third issue of this opportunity is **opened from September 2022 to March 2023**.

For industries interested in bidding, the procedure is as follows:
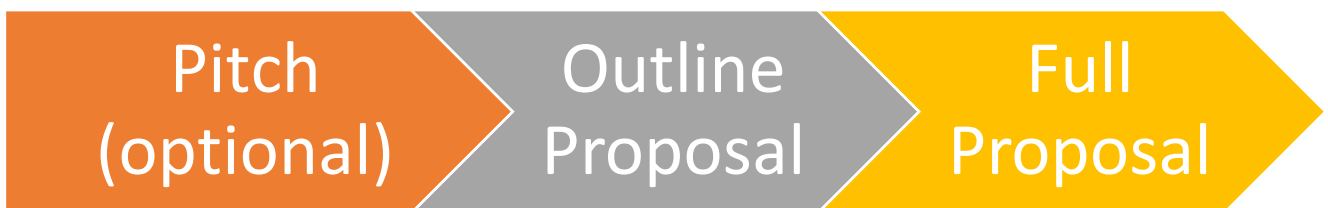


## 4.2. Step 1: pitch (optional step)

Interested potential companies are invited to submit their ideas(s) by either submitting a pitch proposal (word document) or **making a pitch presentation** (powerpoint document).

Please note that the pitch is of interest to the companies whenever preliminary feedback from ESA is desirable. **In case the Industry has a clear mind about the product it wants to develop, a pitch is not necessary** and the Industry can submit directly an outline proposal.

The pitch proposal or presentation should contain as a minimum the following information:

⎯ Outline of intended scope of the proposed 4S activity(ies);

⎯ Objective(s) of the Company in this line of activity;

⎯ Description of considered innovative elements;

⎯ Indication on the nature of the activity(ies) within the development life cycle (e.g., definition, technology de-risk, possible security aspects, product development, pre-operational demonstration);

⎯ Commercial viability (preliminary business case including financial data);

⎯ Level of non-EU dependency;

⎯ Future level of investment required related to the development life cycle.

A suggested template for the Pitch Proposal is provided in [PP].

Industries interested to submit their ideas shall either:

— contact ARTES-4S@esa.int to organise a pitch presentation with the 4S SPL team. ESA will provide its official feedback within 10 working days after the pitch presentation.

— submit the complete pitch proposal to ARTES-4S@esa.int. ESA will assess the pitch proposal within 10 working days.

Following a first contact with the 4S SPL team or submission of a pitch proposal, interactions with potential partners may be required and ESA may therefore offer support in providing further clarifications, aimed at better shaping the outline proposals.

If the pitch is positively assessed, ESA will invite the Industry to proceed to the next step (outline proposal).

## 4.3. Step 2: outline proposal

The outline proposal is expanding the pitch proposal/presentation with more details.

The outline proposal shall address as a minimum the following aspects:

— Outline of the proposed 4S activity or activities;

— Objective(s) of the proposed activity;

— Description of innovative technology elements;

— Description of possible security aspects and relevant Security Risk Management;

— Design & Development Plan, IOT/IOV Approach, Demo Plan as applicable;

— Business Perspective on global market and/or European institutional opportunities;

— Industrial Organisation and Programme of Work;

— Link to relevant national and/or EU initiatives as applicable;

— Funding Plan and cost estimates.

Outlines proposals shall be submitted to ARTES-4S@esa.int[1]. ESA will commit to evaluate the outline proposal within 10 working days.

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[1] Any proposal submitted after the deadline of this AO will automatically revert to the technology and product permanent open Call for Proposals 'ARTES 4.0 Technologies and Product for C&G, Scylight, 4S and 5G' (AO 10285)

Templates for submitting the outline proposal are available here: Documents | ESA TIA (sections "templates for all ARTES projects" and "templates for co-funded technology and product developments").

If the outline proposal is positively assessed, ESA will invite the Industry to proceed to the next step (full proposal).

## 4.4. Step 3: full proposal

Following the submission of the outline proposal, in case of a positive assessment from ESA, interested potential partners are invited by ESA to submit their full proposal with the **Authorisation of Funding** from the relevant National Delegation(s) via ESA-star[2], in line with the procurement process of the open Call for Proposals 'ARTES 4.0 Technologies and Product for C&G, Scylight, 4S and 5G' (AO 10285).

The full proposal is the consolidation of the outline proposal with a deeper level of details.

The full proposal shall address as a minimum the following aspects:

— proposed 4S activity or activities;

— Objective(s) of the proposed activity;

— Description of innovative technology elements;

— Design & Development Plan, IOT/IOV Approach, Demo Plan as applicable;

— Preliminary Security Risk Assessment, relevant both to the protection of the know-how developed during the activity implementation and to possible specific security aspects inherent to the proposed development;

— Business Plan highlighting the business perspective on global market and/or European institutional opportunities;

— Industrial Organisation and Programme of Work;

— Link to relevant national and/or EU initiatives as applicable;

— Funding Plan and cost estimates.

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[2] https://esastar.sso.esa.int/

Following a positive assessment by ESA and successful negotiations with the Industry, the proposed activity will be approved for implementation and a Contract will be made between the Industry and ESA.

Templates for submitting the full proposal are available here: Documents | ESA TIA (sections "templates for all ARTES projects" and "templates for co-funded technology and product developments").

## 4.5. Authorisation of Funding from National Delegation(s)

Formal authorisation from the National Delegation(s) of the companies involved **is required** for the proposed activity at the time of submission of the full froposal. Full proposals submitted without the Authorisation of Funding will not be evaluated.

Bidders are advised to initiate discussions with the relevant National Delegate(s), **as early as reasonably possible**. ESA suggests reaching out the National Delegate(s) when submitting the pitch, and to inform ESA about the feedback of the Delegations by the time of submitting the outline proposal.

The address book of the National Delegates can be found here: https://artes.esa.int/national-delegations.

## 4.6. Evaluation Criteria

The evaluation process is non-competitive, as each proposal will be assessed individually on its own merits.

For any pitch / outline proposal to be considered as an adequate basis for further consideration, the following elements will be evaluated:

1. Consortium experience in 4S-related product and system development;
2. Credibility of the technical solution, addressed challenges and implementation plan;
3. Management organisation, including management of risks / security handling;
4. Adequacy of cost and funding, costs transparency;
5. Credibility of the business case;
6. Level of European non-dependence.

For the full proposal, the standard evaluation criteria defined in AO 10285 will be used.

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## 4.7. Development phases

To prepare your pitch, outline and full proposals, please consider the information about the ARTES 4.0 Technologies and Products programme element provided on the ARTES web site https://artes.esa.int. In particular, the required objectives per Development Phase and Segment shall be respected, as shown in the table hereafter:

| *Development Phase* | *Main Activities* | *Outcome* |
|---|---|---|
| Definition Phase | Technical studies, preparatory activities | Performance requirements defined, or system analysis completed |
| Technology Phase | Technical risk mitigation excluding any qualification or industrialisation. | Breadboard, prototype or Engineering Model (EM)<br><br>Flight hardware for early in orbit test purposes. |
| Product Phase | Development, qualification, verification and industrialisation | **Space product**: Engineering/Qualification Model (EQM) or similar |
| | | **Ground product**: verified product in a non-operational environment, end-to-end infrastructure |
| Demonstration Phase | **Space system**: in-orbit validation/demonstration | Flight hardware, system demonstrations |
| | **Ground product**: validation in operational environment | Product validated in an operational environment, system demonstrations |

## 4.8. ESA Co-funding levels

The following table shows the applicable Technical Readiness Levels (TRL) and maximum funding level for each Development Phase:

| Development Phase | Targeted TRL | ESA maximum Co-Funding Level | | |
|---|---|---|---|---|
| | | Non-SME | SME | Universities or Research Institutes with no commercial interest in the product or system |
| Definition Phase | | 50% | 80% | 50% |
| Technology Phase | up to 4-6, depending on the technical risk | 75% | 80% | 100% |
| Product Phase | up to 7 | 50% | 80% | 50% |
| Demonstration Phase | up to 8 | 50% | 80% | 50% |

## 4.9. 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, in the outline proposal or in the full proposal. Nevertheless, should it be considered necessary to share Classified Information with the Agency in an outline proposal, the Agency should be notified beforehand so that mutual agreement can be reached on how to handle such information.

To avoid any confusion with Classified security markings, the unclassified protective marking used by the Tenderer in the pitch proposal/presentation, outline proposal and full proposal shall not contain the terms: "Restricted", "Confidential", or "Secret".

ESA is subject to a Personal Data Protection Framework and will process and protect personal data accordingly. Personal data provided in the outline proposal will be processed solely for the purposes of evaluating the outline proposal and, should the evaluation be successful, executing subsequent steps of the procurement process. Further information on personal data protection can be found in the Special Conditions of Tender element of the ARTES 4.0 Technologies and Products Call for Proposals.

Expenses incurred in the preparation and dispatch of the response to the announcement will not be reimbursed. This includes any expense connected with a potential dialogue phase.

This announcement does not bind ESA in any way to place a contract. ESA reserves the right to issue amendments to this announcement.