Satellite Connectivity for Autonomous Land vehicles Safety (4S)

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Table of Contents

[1. Background and Rationale 4](#_Toc115779335)

[2. Scope of Thematic Call 6](#_Toc115779336)

[3. Objectives 8](#_Toc115779337)

[3.1. THE VALUE OF SPACE ASSETS 9](#_Toc115779338)

[3.1.1. Satellite Telecommunications 9](#_Toc115779339)

[3.1.2. Earth Observation 10](#_Toc115779340)

[3.1.3. Satellite Navigation / GNSS 10](#_Toc115779341)

[4. Procurement Approach 11](#_Toc115779342)

[5. Process and Schedule 11](#_Toc115779343)

[5.1. Timeline and Procedure 11](#_Toc115779344)

[5.2. Evaluation Criteria 13](#_Toc115779345)

[5.3. General Conditions 13](#_Toc115779346)

[**ANNEX 1- Scope of ARTES 4.0 SPACE SYSTEMS FOR SAFETY AND SECURITY (4S)** 15](#_Toc115779347)

1. Background and Rationale

With massive bandwidth requirements due to highly sophisticated software systems, the Connected Cars connectivity market represents a huge addressable market, expected to reach USD 1 billion in 2029 , requiring a global network leveraging both satellite and terrestrial technologies to connect cars everywhere. Satellite communications play an important role to ensure ubiquitous accurate coverage, highly efficient broadcast to deliver common content from one-to-many vehicles everywhere and extraordinary levels of resiliency and security. The connectivity is extremely important not only for safety related data sharing purposes, but also for real-time high-precision GNSS positioning allowing the GNSS corrections to be sent to the rover receiver and enhance navigation performance. Safe and secure connectivity will be needed for the distribution to one or more vehicles (belonging to a group or being in a specific area) of high-definition maps for precision navigation, software and firmware upgrades of vehicles’ on-board computers, and other Intelligent Mobility services. Terrestrial 5G will be a key element of this network, however it is satellite connectivity that will ensure that connectivity is ubiquitously available, even in remote and rural areas, or in case of a failure, thereby maintaining safety functionality and paving the way for faster deployment of future connected and autonomous vehicles and guaranteeing that mobility services such V2X (Vehicle-to-Infrastructure) connectivity are available. V2X, that is 'Vehicle-to-Everything’, refers to the communication of a vehicle with any other entity being a vehicle, infrastructure, pedestrian, or network, and relies strongly on the connectivity. The combination of terrestrial and satellite communication networks is making possible intelligent and ubiquitous V2X systems with significantly enhanced reliability and security, hyper-fast wireless access, as well as much seamless communication coverage.

For example, satellites can multicast updates to cars concerning road conditions ahead, local imaging of city streets and mapping of selected routes. Such information is necessary to enable the connected autonomous cars to “make decisions” as they move from place to place. These connected and intelligent cars need to have a massive repository of know-how built in them to ensure that they can be autonomous, and this know-how must be continually updated and kept secure. Satellites are reliable and efficient means of downloading these massive amounts of data simultaneously into every car on the highway within a region or across multiple countries, depending upon the need of the manufacturer. In addition, auto manufacturers can use the broadcast capabilities of satellites to update connected car operating software, thereby avoiding costly recalls and updating the software one car at a time at dealerships.

In addition to the cars, Connected Autonomous Vehicles (CAVs) address several other types of land vehicles. An autonomous truck similarly, is equipped with technology that allows it to communicate with other vehicles and road infrastructure, assess traffic situations and make right driving decisions. Testing of autonomous trucks or a platoon of trucks is on-going in several countries. Other examples are the autonomous shuttles that are located around convenient public infrastructure hubs, such as business campus, airports, train stations, bus stations, shopping centres and large public or commercial buildings and parks... Fundamental for the safety of the autonomous vehicles is the provision of seamless connectivity that can be achieved by the convergence of satellite communications and terrestrial networks.

Another significant challenge in this sector is cybersecurity vulnerabilities. As the car and other land vehicles sector grows dependent on connectivity, it becomes an increasingly attractive target for cyber-attacks. The automotive industry has realized the potential impact of its exposure, and satellite communications may support the development of cyber resilient connectivity systems.

The objective of this Thematic Call this unique value looking at the shipping and toying eating with us as to what is the is the major contributor foris to foster the development and deployment of innovative innovative services and applications which embed space assets for the safe and secure deployment and management of autonomous and connected land vehicles (4S).

These activities will have to be performed in cooperation with end–users and stakeholders and are aimed at:

* raising customers’/users’/stakeholders’ awareness of these new applications and benefits brought by satellite communications, and getting their buy-in
* consolidating users’ needs and requirements for both application elements and satellite communications services
* preparing for the development and roll-out of the operational solutions and associated commercial offer

During the activities, integration with future satellite telecommunications infrastructures may also be investigated, in view of paving the way for future proof-of-concepts and demonstrations.

The Thematic Call theme and use cases originate from the results achieved on recent activities undertaken within the frame of the BASS Generic Programme Line with industry and relevant stakeholders in the sector of autonomous and connected cars.

The following stakeholder categories are relevant and are planned to be involved in the definition of requirements for this call:

• Government departments

• Municipalities and cities

• Road management operators

• Automotive and cars manufacturers.

The proposals shall focus on the design, development and demonstration of space-based services addressing the involved stakeholders’ requirements in the autonomous land vehicles sector. A preliminary list of applications areas (c.f. Section 2 of this document) have been identified from these consultations. Other applications areas may be proposed by Tenderers, if duly justified.

This Thematic Call is part of the ESA ARTES (Advanced Research in Telecommunications Systems) 4.0 programme of ESA in the context of the Strategic Programme Line (SPL) “Space Systems for Safety and Security (4S)” work plan. Scope and objectives of 4S SPL can be found in Annex 1.

1. Scope of Thematic Call

The objective of this call is to demonstrate the key benefits that satellite connectivity can bring to support the autonomous land vehicles sector. The thematic call purposely addresses a wide spectrum of applications including but not limited to the use cases below.

* **Use Case 1: Connected cars performance parameters remote collection and processing**

identified from road testing and/or related to V2X connectivity status

Automotive industries need reliable, consistent communications capabilities. Usually, they rely on terrestrial communication networks that, however, might be impacted by limited coverage in terms of capability and functionality. Therefore, they might adopt satellite communication systems to complement terrestrial networks (e.g. LMR, LTE, etc.) in a situation of emergency.

* **Use Case 2: • Seamless transition between 4G/5G and satellite communication**

Seamless transition between 4G/5G and satellite communication for V2X and massive info transmission, such as road and safety information in remote areas.

When vehicles drive in remote areas where terrestrial connectivity is not available might have limited communication coverage.

Vehicles are expected to leverage hybrid connectivity (cellular and satellite) and they will automatically switch to the most convenient network by ensuring coverage in every situation.

* **Use Case 3: Traffic management in disaster situation**

Terrestrial communication networks that, however, might be impacted by the disasters or limited in terms of capability and functionality. Satellite communication systems could be adopted as a back up to terrestrial networks (e.g. LMR, LTE, etc.) particularly suited to address a situation of emergency or disaster.

* **Use Case 4: Commercial Fleet management and logistics (including truck platoons)**

Commercial fleet are increasingly relying on uninterrupted connectivity for fleet management and logistics purposes. Digitalisation of the fleet is usually relying on available telecommunication technologies such as 4G; however, in some cases like long-haul, a fleet manager may find satellite communication an appealing solution to monitor the health and condition of its assets.

In a longer term, formation of platoons may require continuous connectivity, i.e. group of vehicles (e.g. trucks that travel from warehouse facilities to a transportation area such as rail, shipping) that drive closely with a fixed distance, in a coordinated manner, to decrease fuel consumption, increase logistics efficiency and reduce traffic congestion. Specifically, satellite telecommunications are instrumental in remotely monitoring platooning operations and multicasting safety information as backup in non-terrestrial coverage areas.

* **Use Case 5: Internet of Things (IoT) providing connected devices for on field monitoring and connected vehicles**

The Internet of Things (IoT) is an evolving technology with very broad adoption prospects. The increasing availability of sensors and actuators of smaller dimensions and lower power consumption has driven the adoption of Internet of Thing technology across a wide range of sectors including auton. In this context, connected devices can be adopted to monitor, alert, and respond. IoT technology is empowering the “connected operations” throughout vehicles telematics and smart monitoring sensors (e.g. narrowband sensors, security cameras, etc.).

* **Use case 6**: **Real-time hazard warning**

This use case relates to an autonomous vehicle receiving information relevant for the road/route ahead that require to increase driver awareness or reduce reliance on automated vehicle features like lane keeping. The information could be related to a hazardous location real ahead, a route obstruction, potholes, or others.

* **Use Case 7: Hazard information collection and sharing**

Vehicles collect hazard and road event based on vehicle sensor data for further use by autonomous vehicles (AVs) and V2X application servers. Sharing of this information can be done via satellite communications for areas where mobile network coverage is low.

* **Use case 8: High Definition map update.**

This use case relates to vehicles that are receiving a HD map updated in real-time for accurate trajectory planning and collision/congestion avoidance. For this case, timely and reliable communication is needed, and high reliability is a key parameter.

* **Use case 9: Harmonization of satellite spectrum allocation and communications standardisation**

The harmonization of satellite spectrum allocation and communications standardisation to allow autonomous and connected cars to be seamlessly and globally interoperable, reducing costs and complexity for the manufacturer.

* **Use case 10: support the transmission of data and information between the vehicle and the Cloud or other infrastructures in urban and rural areas**

Analyse and define the technology capabilities, features and services of satellite communications systems that can support the transmission of data and information between the vehicle and the Cloud or other infrastructures in urban and rural areas.

To achieve such objectives and address the above use cases, the proposed services shall rely primarily on safe and secure satellite telecommunications already available or available in the short term. During the activities, integration with future Satellite telecommunications infrastructures may also be investigated, in view of paving the way for future proof-of-concepts and demonstrations. Services using other space assets, technologies and data in addition to satellite communications are also welcomed.

1. Objectives

Activities to be presented in response to the Call for Proposals are Demonstration Projects. The “Management Requirements” (MR) document available as Appendix 3 to the Draft Contract (self-standing document in the tender) provides a set of guidelines regarding the programme of work and management of such projects.

The specific scope of the activities presented in response to this Call for Proposals is to be defined by the Tenderer, but it shall in any case:

1. Be in line with the general objectives set forth in Section 1 of this cover letter and be in line with the programmatic objectives of the ARTES 4.0 4S Strategic Programme Line (SPL) as outlined in Annex 1 hereto;
2. Address one (or more) area(s) described in Section 2 hereto and propose to design and develop one (or more) service(s) relevant for this (these) area(s). Other applications areas may be proposed by Tenderers, if identified by representative stakeholders of relevance for their operations.
3. Be customer/user driven: The Tenderer shall involve in the project representatives from users’ communities, which shall take part in the pilot. The Tenderer shall include a letter of intent from each involved user as evidence of their commitment and support to the project.
4. Prove the benefit of using space assets including either safe and secure satellite telecommunications systems and/or other space assets (Earth observation, Satellite Navigation) for the proposed service(s).
5. Shall set-up a pilot trial/demonstration to verify and deploy in a pre-operational environment the proposed service(s) with the involvement of the engaged users/customers. This pilot shall aim at collecting feedback from end users, demonstrate the benefits of the satcom-based service(s), consolidate user and system requirements, and promote the new service(s).
6. 6. Include the potential service provider as part of the tendering team.
   1. THE VALUE OF SPACE ASSETS
      1. Satellite Telecommunications

The digital transformation (e.g. remote control, real-time monitoring, data analytics) and the adapted ways of working resulting from implementing these new ways are driving the need for secure and reliable connectivity (broadband and narrow band) in the autonomous transport domain.

Satellite communications are in a unique position to answer to these needs by:

* complementing and extending mobile and fixed terrestrial coverages, or as unique telecommunications means.
* Used as a redundant system to enhance the resilience of terrestrial networks used for critical communication and guarantee operations continuity in the event of terrestrial networks downtime.

It is also expected that the enhanced capabilities of future satellite communications infrastructures, especially reduced latency, terminal size, service price, as well as increased network availability, will be the key features to support the autonomous transport safety.

* + 1. Earth Observation

Earth observation data is becoming increasingly available by a multitude of sensors and systems in orbit and the associated data analytic services. With respect to applications and services addressing the autonomous land vehicles safety, a preliminary and non-exhaustive list is provided below:

* Providing imagery enabling services such as mapping, risk detection, situational awareness, assessments of hazard, road blockages etc.
* Providing weather data and forecasts.
* Up to date geodata (maps, aerial pictures etc.).
* Providing ad-hoc maps/images of disasters, like flooding.
  + 1. Satellite Navigation / GNSS

In the context of autonomous land vehicles safety applications, GNSS is providing a crucial value, on its own or integrated with communications:

* Ubiquitous high accuracy PNT technologies to support accurate and seamless positioning provided by GNSS, 5G and other complementary terrestrial and on board systems.
* Tracking data coming with SatEO derived information can strengthen traceability systems to show the speed of a device or vehicle, the location of a device or user in a certain geographical area.
* The navigation of emergency vehicles to an accident site.
* Tracking and monitoring of assets, e.g. vehicles, drones.

1. Procurement Approach

The proposals to be submitted in the context of this call shall be implemented in accordance with the current tools provided by ARTES GPLs (Generic Programme Lines) and/or SPLs (Specific Programme Lines) in direct negotiation (co-funded) with Industry, depending on their nature and scope, and in coordination with National Delegations.

Existing ARTES mechanisms shall be used without modification. The eligibility criteria shall be in line with the ARTES implementation rules.

The call aims at attracting specifically SMEs, New Space and Spin-In Industry, although open to all Industry in ESA Member States participating in the ARTES programme. To this purpose, an Outline Proposal (OP), based on a template provided by ESA attached here on this website, shall be used as entry point for companies to submit their idea, providing a simplified and single point of access to the ESA ARTES framework.

According to the rules of the ARTES GPL and SPL programmes, the price of activities carried out in a given ESA Member State are charged against the contribution of that State in the programme. Letter(s) of Authorisation of Funding (AoF) from the relevant National Delegation(s) is(are) therefore required as part of the Full Proposal. The Industry is however advised to inform the relevant National Delegation(s) when submitting the Outline Proposal(s). The coordinates of the National Delegates can be found here: <https://artes.esa.int/national-delegations>

The Proposal(s) by the Industry can cover multiple themes and vertical integration between Technology, Products, Services and Applications. The Proposal(s) can also cover one or multiple phases of the full life cycle of activities including definition, technology and product developments, and demonstration in a pre-operational environment.

1. Process and Schedule
   1. Timeline and Procedure

The Thematic Call is open from **1 November 2022** for Industry to respond by submission of Outline Proposals (OP) until **28 February 2023**. Industry can submit Outline proposals anytime during this interval. Outline Proposals received after this date will not be evaluated within the batch of this theme. The timeline of the full process is illustrated below.

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In **Step 1**, ESA will release the Thematic Call. Following the release, the interested Industry partners are invited to submit their Outline proposal(s) (OP) based on a template made available by ESA that can be downloaded from the Thematic Call website.

When completed, the Outline Proposal file shall be saved with name: **"Connectivity for Autonomous Land Vehicles Safety (4S)-** [Your Activity Name].docx" in **Word document format** (**or** as PDF) with the text in red to be replaced with the title of your proposed activity. It should then be submitted via the online web submission form which is accessible on the call website:

<https://business.esa.int/funding/intended-tender/satellite-connectivity-for-autonomous-land-vehicles-safety>

In parallel the interested Industry shall contact the relevant ESA Member States Delegates to verify their interest and their preliminary support.

After the deadline for submission of the OP, ESA will assess the Outline Proposal and provide feedback to the company.

It is recognised that some interactions with the Industry may be required and ESA may therefore consult with the Industry and may offer support in providing further clarifications, aimed at better shaping the Outline Proposal(s). Dialogue sessions may be organised individually with potential partners prior to Step 2.

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).

In **Step 2**, subject to a positive assessment from ESA and preliminary support from the National Delegations, the Industry will be invited to submit a Full Proposal in accordance with the ARTES programmatic line Business Applications (BASS AO 1-10494), and the applicable procurement process including the template to be used for the Full Proposal generation.

Following this invitation by ESA, the Industry will submit a Full Proposal with the Authorisation of Funding (AoF) from the relevant National Delegation(s) **not later than 30 May 2023**.

Following a positive assessment by ESA the proposed activity will be approved for implementation.

* 1. Evaluation Criteria

The evaluation process is non-competitive, as each proposal will be assessed individually on its own merits. For any Outline Proposal to be considered as an adequate basis for further consideration, the following evaluation criteria will be used:

1. Consortium experience in technical and business matters relevant to the proposed product, technology and applications;
2. Proposed management organisation, including management of risks;
3. Adequacy of cost and funding;
4. Potential for future evolution towards a demonstration project and commercial solution on a global market and/or towards European opportunities and associated return on investment;
5. Market potential and credibility of business planning, potential to deliver positive net socio-environmental impact
   1. 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 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 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.

**ANNEX 1- Scope of ARTES 4.0 SPACE SYSTEMS FOR SAFETY AND SECURITY (4S)**

Our society, economy, security and sovereignty are increasingly dependent on the 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 those “4S-related” communication services and networks that are required for essential governmental or institutional services (at national, regional or local levels) or support operations that are 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, our 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. At the same time, as the overall presence of Europe and Canada in the design and manufacturing of these terrestrial network solutions tends to decrease, this can only negatively impact our actual level of control of this essential infrastructure and have serious implication on European and Canadian safety, security and sovereignty.

In that context, it is growingly perceived that adding appropriately tailored secure Next Generation SatCom components to our telecommunication infrastructure may greatly help to increase its overall resilience to any kind of disruption, bring additional capacity and ensure its global coverage while providing a stand-alone highly secure space-based capacity to channel the most sensitive and critical communications services.

ESA, through the ARTES Programme, is fully committed to support the European Satcom sector in the effort to put forward competitive solutions in Satcom domain. Importance of responding to institutional and public-regulated needs has been fully recognized: a new Strategic Programme Line for “Space Systems for Safety and Security” (4S) has been launched in 2019. 4S has a double objective:

* To support competitiveness to enable European industry to benefit from the significant economic opportunity and growing world-wide demand for “4S” SatCom solutions.
* To respond to the growing European societal and institutional needs in Safety and Security.

It is also the ambition of 4S to bring ESA support to sectorial public bodies in their SatCom-related endeavours, and to European Commission for more specific initiatives such as to EU GOVSATCOM, to the EU Single European Sky and the EU Quantum Flagship initiatives.

To pursue those goals, 4S covers the full life cycle of secure Satcom and related downstream applications, across the full range of the ARTES programme, from upstream to downstream activities. This includes preparatory work and product development (Future Preparations, Core Competitiveness), Partner Projects and Business Applications, all within one coherent framework in support to 4S.