



EN

Horizon 2020

Work Programme 2018-2020

*5.iii. Leadership in Enabling and Industrial Technologies -
Space*

IMPORTANT NOTICE ON THIS WORK PROGRAMME

This Work Programme covers 2018, 2019 and 2020. The parts of the Work Programme that relate to 2020 (topics, dates, budget) have, with this revised version, been updated. The changes relating to this revised part are explained on the Funding & Tenders Portal.

(European Commission Decision C(2020)1862 of 25 March 2020)

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Introduction

Space is important for Europe. It is both a strategic asset and enormous opportunity for our society and economy. Space technologies, infrastructure, services and data provide the EU with the tools needed to address societal challenges and big global concerns, such as climate change, migration, mobility, energy security and many others. The security and well-being of our citizens increasingly depend on information and services provided from space.

Space has a growing importance for the European economy. Space provides data and connectivity for the digital economy. It boosts innovation and creates new sources of jobs and growth, particularly through the development of value-added (downstream) products and services, which opens new market opportunities for European companies, including SMEs and start-ups, and contributes to the competitiveness of our economy. Space can help increase the resilience of key sectors of the economy, such as transport networks, energy grids, or financial and banking services. The importance of space for the functioning of European society is expected to grow in the future as we move towards a more interconnected society and digital data-driven economy which will increase the demand for space-based services.

To bring the benefits of space to the European citizens and unleash the potential of space as a vector for growth, competitiveness and jobs creation in the wider European economy it is necessary to stimulate the integration of space into European society and economy, foster a globally competitive European space sector and ensure European autonomy in accessing and using space in a safe and secure environment.

The Horizon 2020 interim evaluation confirmed that the objectives and challenges of LEIT-Space remain highly relevant and are fully in line with *the Space Strategy for Europe*, adopted by the Commission on 26th October 2016. It sets out the following priorities:

- Maximising the benefits of space for society and the EU economy;
- Fostering a globally competitive and innovative European space sector;
- Reinforcing Europe's autonomy in accessing and using space in a secure and safe environment;
- Strengthening Europe's role as a global actor and promoting international cooperation.

Horizon 2020 is a key instrument to progressing towards these goals. This must be done in coordination with the activities of the operational space programmes Copernicus and EGNSS (Galileo and EGNOS), with activities in other parts of Horizon 2020 and with the activities of Member States and ESA.

The interim evaluation also found that industrial participation in LEIT-Space stands at 53% with an SME participation around 28% including the Space part of the SME-instrument, which is far above the 20% target. Furthermore, there is a healthy influx of new participants. Indeed some 45% of the participants are newcomers from industry.

In line with this, and in the light of the strategic orientations of Horizon 2020 for the final three years, the space part will:

- Support the market uptake and evolution of the Copernicus and EGNSS (Galileo/EGNOS);
- Underpin space business, entrepreneurship, space technologies and science;
- Support security aspects and access to space;

Applicants are reminded that other space-related opportunities are available elsewhere in the Horizon 2020 work programme. A non-exhaustive list includes: (i) the European Innovation Council (EIC) pilot, in particular the SME-instrument, the EIC Horizon price on 'Low-cost space launch', the Fast Track to Innovation (FTI) and the FET Open (Future and Emerging Technologies); (ii) the Access to Risk Finance, in particular the InnovFin Space Equity Pilot (ISEP) in the context of InnovFin Equity. In addition to these, more specific opportunities, such as those linked to research infrastructures or societal challenges, are recalled in the related topics in this part of the work programme.

Horizon 2020 space should be a tool in support of the European space sector in the global context. The development of cutting edge space technology is increasingly taking place within space science and exploration international partnerships. Ensuring access to these constitutes an important success factor for European researchers and industry. The use of space will have to take into account cooperation with international partners. Accordingly, international cooperation aspects will be mainstreamed in the work programme as far as possible.

Topics of this part of the work programme will contribute to the following focus areas:

- Building a low-carbon, climate resilient future
- Digitising and transforming European industry and services
- Boosting the effectiveness of the Security Union.

Responsible Research and Innovation

Activities carried out under this Work Programme should be in line with Responsible Research and Innovation (RRI)¹, thereby engaging society, integrating the gender and ethical dimensions, ensuring the access to research outcomes and encouraging formal and informal science education.

Open research data

Grant beneficiaries under this work programme part will engage in research data sharing by default, as stipulated under Article 29.3 of the Horizon 2020 Model Grant Agreement (including the creation of a Data Management Plan). Participants may however opt out of

¹ <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation>

these arrangements, both before and after the signature of the grant agreement. More information can be found under General Annex L of the work programme.

Guidance documents relating to certain call topics

For certain call topics, additional guidance for the applicant is available through "guidance documents" published on the Funding & Tenders Portal.

Synergies with other funding opportunities in WP2020

Project proposers should consider and actively seek synergies with, and where appropriate possibilities for further funding from, other relevant EU, national or regional research and innovation programmes (including ERDF/ESF+ or the Instrument for Pre-accession Assistance [IPA II]), private funds or financial instruments (including EFSI).

Examples of synergies are actions that build the research and innovation capacities of actors; mutually supportive funding from different Union instruments to achieve greater impact and efficiency; national/regional authorities actions that capitalise on on-going or completed Horizon 2020 actions aimed at market up-take/commercialisation.

In order to explore options for synergies, project proposers could seek contact with national/regional managing authorities and the authorities who developed the Research and Innovation Smart Specialisation Strategies (RIS3)². For this purpose the 'Guide on Enabling synergies between ESIF, H2020 and other research and innovation related Union programmes'³ may be useful. Horizon 2020 project proposals should outline the scope for synergies and/or additional funding, in particular where this makes the projects more ambitious or increases their impact and expected results. Please note, however, that while the increase in the impact may lead to a higher score in the evaluation of the proposal, the reference to such additional or follow-up funding will not influence it automatically.

Guidance Document	Call Topic/Other Actions
Copernicus evolution: guidance document for Horizon 2020 Work Programme 2018-2019	LC-SPACE-02-EO-2018; LC-SPACE-03-EO-2018 LC-SPACE-04-EO-2019-2020
Critical Space Technologies: guidance document for Horizon 2020 Work Programme 2018-2020	SPACE-10-TEC-2018-2020
Space Robotics Technologies - Strategic Research Cluster: guidance document for Horizon 2020 Work Programme 2018-2020	SPACE-12-TEC-2018 SPACE-27-TEC-2020

² <http://s3platform.jrc.ec.europa.eu/map>

³ http://ec.europa.eu/regional_policy/sources/docgener/guides/synergy/synergies_en.pdf

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Electric Propulsion - Strategic Research Cluster: guidance document for Horizon 2020 Work Programme 2018-2020	SPACE-13-TEC-2019 SPACE-28-TEC-202
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Contribution to focus area(s)

Focus Area 'Digitising and transforming European industry and services' (DT): EUR 58.00 million

Focus Area 'Building a low-carbon, climate resilient future' (LC): EUR 84.00 million

Focus Area 'Boosting the effectiveness of the Security Union' (SU): EUR 98.10 million

Call - Space 2018-2020

H2020-SPACE-2018-2020

Earth observation

Horizon 2020 Earth observation (EO) activities are considered an essential element to accompany the investments made by the Union in Copernicus, the Union Earth observation and monitoring programme. Through Copernicus and Earth Observation activities in the Horizon 2020 the European Union also contributes to advancing the Global Earth Observation Systems of Systems (GEOSS).

In particular, activities under the societal challenge for climate action, environment, resource efficiency and raw materials focus on contributing to and drawing benefit from GEOSS. This aims notably at the development of comprehensive and sustained global environmental observation and information systems that stimulate the smart use of strategic resources, support the development of evidence-based policies, foster new environmental and climate services, and develop new opportunities in global markets. Activities under the Leadership in Industrial Technologies part focus on the evolution of Copernicus and the exploitation of existing European space infrastructure by promoting the development of innovative products and services based on remote sensing, geo-positioning or other types of satellite enabled data as well as geo-information generated already by services such as Copernicus services.

It is widely accepted that the combination of the aforementioned information sources with data from outside the Earth Observation domain has a vast potential to generate new and innovative applications and services. Activities under the present heading will focus on the use of existing technologies that emanate from previous work programmes throughout Horizon 2020, from Member States and from ESA to integrate them into their work and progress their maturity towards operational use.

Currently most of the EO innovative applications are integrating different technologies. Further developments in the frame of integration of Earth Observation (EO) systems with EGNSS and other technologies are encouraged in order to deliver added value services fully tailored to end user needs. Optimised system architectures have to be defined to fully exploit the potential of synergies/complementary characteristics of the different systems, providing significant benefits in a number of key market segments and operational scenarios.

Moreover, taking into account the wider relevance of EO to all parts of Horizon 2020, proposals addressing application and uptake of EO for the development of innovative applications addressing specific challenges can also be submitted to the Horizon 2020 Societal Challenges where related references are included. To that end, applicants to those parts of Horizon 2020 can also access Copernicus data and information (licensing conditions may apply).

To render the exploitation of Copernicus more efficient, the Union is putting in place a number of Data and Information Access Services (DIAS) that will start operation in the

context of the Copernicus programme in 2018.⁴ The DIAS will offer access to Copernicus data and information and offers computing resources and tools alongside the data to facilitate working with the data without the need to download it. To maximise the impact of past H2020 initiatives, the Union intends to make all relevant and freely available tools developed under H2020 available within the DIAS environments, helping them to become European 'algorithm factories'. Activities under the Leadership in Industrial Technologies part are encouraged to integrate the DIAS as enabling element in their work.

Widening the use of Copernicus data and enhancing the market uptake of Copernicus services by delivering new applications relying on Copernicus services and Earth observation data. Further evolution of Copernicus by developing innovative solutions to improve services and by exploring mission concepts such as marine service ocean models and CO₂ monitoring capability in the context of implementing the Paris Agreement on climate change.

To facilitate access to opportunities for applicants, the following list includes some of the dedicated Earth observation activities in this and other parts of Horizon 2020 work programme:

Excellent science – Research Infrastructures

- INFRAEOSC-01-2018: Access to commercial services through the EOSC hub
- INFRAIA-01-2018-2019: Integrating Activities for Advanced Communities

Leadership in Industrial Technologies – space part:

- DT-SPACE-01-EO-2018-2020: Copernicus market uptake
- LC-SPACE-02-EO-2018: Copernicus evolution – Mission exploitation concepts
- LC-SPACE-03-EO-2018: Copernicus evolution – Preparing for the next generation of Copernicus Marine Service ocean models
- LC-SPACE-04-EO-2019: Copernicus evolution – Research activities in support of cross-cutting applications between Copernicus services
- LC-SPACE-05-EO-2019: Copernicus evolution – a gap analysis to prepare future activities for Copernicus data and information validation and quality enhancement
- DT-SPACE-06-EO-2019: International Cooperation Copernicus – Designing EO downstream applications with international partners
- LC-SPACE-14-TEC-2018-2019: Earth observation technologies
- LC-SPACE-18-EO-2020: Copernicus evolution: Research activities in support of the evolution of the Copernicus services

⁴ Please see further information on the selected Copernicus cloud-based platforms for Data and Information Access Services at: <http://copernicus.eu/news/copernicus-dias-contracts-signed>

- LC-SPACE-19-EO-2020: Copernicus evolution: new concept for an innovative and holistic solution for Sentinels calibration & validation
- LC-SPACE-24-EO-2020: Copernicus evolution: Mission exploitation concept for WATER
- DT-SPACE-25-EO-2020: Big data technologies and AI for Copernicus
- Other action 13: Copernicus evolution – Research activities in support to a European operational monitoring system for fossil CO₂ emissions

Societal challenges

- SC5-15-2018: Strengthening the benefits for Europe of the Global Earth Observation System of Systems (GEOSS) – establishing 'EuroGEOSS'
- SC5-16-2019: Development of commercial activities and services through the use of GEOSS and Copernicus data

Proposals are invited against the following topic(s):

DT-SPACE-01-EO-2018-2020: Copernicus market uptake

Specific Challenge: Copernicus, the Union's Earth observation and monitoring programme produces a wealth of data and information services on the Earth, its lands, atmosphere, oceans and inland waters, as well as on climate change and in support of disaster management and security. Copernicus data and information services are available with a free and open data licence.

Copernicus data is an integral part of the European Data Economy. Europe needs to strengthen its position as provider of products and services based on data, enabling new market opportunities.

Copernicus data value will be greatly enhanced by its integration with data assets contributed by other vertical domains (i.e. not necessarily from the space/geospatial sector) as well as by leveraging the synergies with EGNOS/Galileo to seize new market opportunities. Many vertical domains, other than space, can benefit from the use of Copernicus.

Mature software technologies such as big data processing and linking technologies, machine learning and artificial intelligence, are widely developed also within the LEIT-ICT Work Programmes of H2020, shall be adopted to offer user-friendly solutions at the scale of the large quantities of data involved. They shall be adopted to contribute to the digitization challenges of the European industry by opening up innovative business avenues and to support societal challenges.

Real-world industrial/commercial requirements, or societal needs, shall drive the Innovation Actions so that the projects' results can find their logical path towards market adoption.

Scope: Actions under this topic should be instrumental to help European companies innovate, develop and bring to market new or improved products and services by exploiting Copernicus data assets and, whenever relevant, the link with European satellite positioning/navigation/timing technologies.

Copernicus data will be at the core of the data value chains and integration activities needed to fulfil the industrial requirements that will drive the proposals.

Proposals should adopt state-of-the-art ICT technologies, such as big data processing and linking technologies, machine learning and artificial intelligence to address the challenges of making sense of large volumes of diverse data from distributed sources, at the scale required to address European and global challenges.

Proposers are strongly encouraged to make use of existing European data infrastructures such as (but not limited to) Copernicus' DIAS platforms, European open data portals, industrial data platforms, and explore synergies with EGNOS/Galileo signals and services whenever those are relevant. Use and re-use of existing data and computing assets is also strongly recommended.

The participation of industry is required to define the project's industrial requirements from the very beginning of the action and to take ownership of the results.

End users (i.e. professional experts and decision-makers as opposed to researchers or software developers) should also be involved to rigorously test the project's solutions to make sure the human factor is considered appropriately.

Proposals must demonstrate that they have access to appropriately large, complex and realistic data sets, in addition to Copernicus. The data assets to be used in the Action should be described in the proposal.

Solid, quantitative and innovative business models should support the proposal giving evidence of the expected industrial, commercial, or societal benefit, and demonstrating a plan towards sustainability after the project's end.

A clear distribution of IPRs amongst the members of the consortium is expected.

For proposals under this topic:

- The participation of at least one industrial partner is mandatory, and the participation of SMEs and start-ups is encouraged;
- Involvement of post-graduate scientists, engineers and researchers and promotion of gender balance is also encouraged, for example through professional work experience or through fellowships/scholarships as applicable;
- A business plan and evidence of user engagement is compulsory and is to be provided as part of the proposal, to demonstrate the user need and sustainability of the project.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Establishment of new sustainable data value chains with Copernicus data at their core with a commercial value;
- Substantial increase in the market of the number of products and services enabled by integrating Copernicus data across sectors with state-of-the-art innovative technologies, able to generate growth and new jobs;
- Enhance European industry's potential to take advantage of market opportunities and establish leadership in the field, as well as boost business activity;
- Increased market share for European companies in the supply of innovative geospatial products and services.

Type of Action: Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-SPACE-02-EO-2018: Copernicus evolution – Mission exploitation concepts

Specific Challenge: The user requirements process undertaken by the Commission and the Space Strategy for Europe has identified possible evolutions of the space observations capabilities in the context of Copernicus. These are described below, and specific guidance documents explaining the ongoing process to gather new user requirements will be provided⁵.

The following three priorities have been identified for potential evolution of Copernicus in the future:

- A. Monitoring of the Polar Regions, notably the Arctic, specifically for sea ice and environmental conditions
- B. Agriculture monitoring, specifically for supporting the Common Agricultural Policy.
- C. Forest monitoring, specifically for supporting the REDD+ (Reducing Emissions from Deforestation and forest Degradation) process at international level.

The development, the implementation and eventually the operation of an enhanced European capacity will need the involvement of various players, such as National Space Agencies, European and Member States Institutions, International Organisations, the private sector, operators of in-situ measurement stations, and of leading scientific experts in the identified

⁵ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

fields such as data assimilation and modelling for the Arctic, agriculture monitoring and forest monitoring. In particular, it will need to build on past activities of the European Space Agency (ESA) and will need to be coordinated with the ESA's on-going and future programmes.

Initiating and consolidating the establishment of the community and thus reaching the critical mass required for addressing such a challenging endeavour. It will also need to take into account current and planned activities led by the Copernicus Programme (space component and services, i.e. marine, climate, land/cryosphere) for future services as well as the current H2020 projects relevant for example for Arctic monitoring (i.e. INTAROS).

Scope: The scope is identified according to the possible evolution scenarios indicated above. Each proposal shall address only one of the following sub-topics.

A – Preparation of a European capacity for monitoring the Polar Regions

To advance a coordinated preparation of a mature European capacity there is a need to bring together the key European stakeholders and competent entities which are:

- Engaged in activities that can answer questions raised in the user requirements gathering process;
- Have the ability to network with suitable research actors to fill the knowledge gaps;
- Have the required expertise to assess the needs for an end-to-end operational system, with due attention to potential international cooperation opportunities for tackling this global challenge.

At the same time, there is a need for an accompanying scientific and technical support to address:

- Ways to improve Copernicus' ability to describe the changing polar regions, including the snow/ice coverage, salinity, sea ice, permafrost, the biogeochemical state of the ocean, biodiversity in light of different scenarios of availability of additional complementary data from space;
- Identification of research gaps regarding integration/assimilation of space based data into sea state, ocean physics, biogeochemistry and ice models;
- Ability to provide not only sea-ice mapping but also sea-ice forecasts for maritime purposes, and as essential climate variable and/or essential ocean variable;
- Assessment of access to adequate and sustained in-situ observing systems and the necessary research gaps to fill in terms of assimilation/modelling capacity.

Activities shall thus encompass the coordination of ongoing efforts, include mutual identification of research and infrastructural gaps, and facilitate a cooperation of further research and development to be undertaken to reach sufficiently mature capacities for an operational integration as a subsequent step.

B – Preparation of a European capacity for improving agriculture monitoring

To advance a coordinated preparation of a mature European capacity in this agriculture monitoring field, there is a need to bring together the key European stakeholders and competent entities which are:

- engaged in activities that can answer questions raised in the user requirements gathering process and under an extended scope of activity;
- have the ability to network with suitable research actors to fill the knowledge gaps;
- have the required expertise to assess the needs for an end-to-end operational system, with due attention to potential international cooperation opportunities for tackling this challenge from local to global levels in a cost efficient way.

At the same time, there is a need for an accompanying scientific and technical support to address:

- Ways to improve Copernicus' ability to support precision agriculture, the monitoring of crop extension and composition, the monitoring of hydrological stress and water needs for irrigation, the forecast of agricultural yields from local and national up to global scale the assessment of crop diseases and nutrient deficiency in light of different scenarios of availability of additional complementary data from space;
- Identification of research gaps regarding integration/assimilation/utilization of space based data for agriculture monitoring at global, European and farmer levels.

Activities shall coordinate ongoing efforts, include mutual identification of research and infrastructural gaps, identify a clear delineation between a core service and a downstream application and facilitate a cooperation of further research and development to be undertaken to reach sufficiently mature capacities for an operational integration as a subsequent step.

C – Preparation of a European capacity for improving forest monitoring

To advance in a coordinated preparation of a mature European capacity in this forest monitoring field, there is need to bring together the key European stakeholders and competent entities which are:

- engaged in activities that can answer questions raised in and beyond the support to the REDD process;
- have the ability to network with suitable research actors to fill the knowledge gaps;
- have the required expertise to assess the needs for an end-to-end operational system at least on a scale of REDD region, with due attention to potential international cooperation opportunities for tackling this challenge from local to global levels.

At the same time, there is a need for an accompanying scientific and technical support to address:

- How to improve Copernicus' ability to support forest management and sustainable logging, the evaluation of forest damage and disturbance, the detection of burned areas, the assessment of forest biomass and health in light of different scenarios including the availability of additional complementary data from space;
- Identification of research gaps regarding integration/assimilation/utilization of space based data for forest monitoring, at global, European, national and local levels.

Activities shall coordinate ongoing efforts, include mutual identification of research and infrastructural gaps, identify a clear delineation between a core service and a downstream application and facilitate a cooperation of further research and development to be undertaken to reach sufficiently mature capacities for an operational integration as a subsequent step.

Both Copernicus Services Evolution and Copernicus Space Component Evolution should be taken into account and aligned optimally. While focusing primarily on the Services Evolution, the coherence between the space component and the service related requirements should also be ensured.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Building a low-carbon, climate resilient future"

Expected Impact: Laying the foundation for complementing the existing Copernicus services and the current Copernicus observation capabilities for operational capacities for:

- A. Arctic as a contribution to an integrated pan-Arctic observing system;
- B. operational agriculture monitoring from local to global levels;
- C. operational forest monitoring from local to global levels, respectively;

Improved the interaction in the context of the evolution of Copernicus with:

- A. Europe's Climate Change challenge and Maritime activities and sustainable development in the Arctic;
- B. Europe's Common Agriculture Policy, of Global Food Security Challenges, as well as farmer level support;
- C. UN REDD process and associated policies, of EU Forest Strategy, as well as of the local forest manager needs;

Lay the foundation for the operational integration of all relevant European capacities as a subsequent step.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-SPACE-03-EO-2018: Copernicus evolution - Preparing for the next generation of Copernicus Marine Service ocean models

Specific Challenge: The overarching challenge is to prepare the next generation of the Copernicus Marine Service in line with the evolution of requirements, policies and national expectations and also benefiting from advances in space, IT technologies and modelling and in accordance with the Copernicus institutional context.

The Copernicus Marine Service has now entered in full-scale operations. It delivers in support to European policies, International conventions (i.e. on climate) and also in support to Member States, observations, forecasts and reanalysis of the past of the ocean, at global scale but also on all European regional seas. It delivers a unique, consistent and integrated overview from the open ocean up to the coasts both in terms of physics and biogeochemistry.

At policy level, many directives related to the marine environment call for integrating in a coherent way all EU policies (the Water Framework Directive, Marine Strategy Framework Directive, the Habitats Directive, Maritime spatial Planning, etc...). EU Ministers have welcomed the [Communication on International Ocean Governance](#), adopted by the Commission and the High Representative in November 2016, calling it a "timely and relevant contribution to achieving [...] better coordination and cooperation to ensure that oceans are safe, secure, conserved and sustainably used and managed." Ministers stressed the urgent need for the EU and its Member States to step up efforts to protect the oceans and seas.

Hence, requirements from the coastal sector interested in integrated coastal zone management, spatial planning, natural risk mitigation, climate change impact mitigation or habitats and living resources monitoring were addressed. From the several improvement paths identified, a high priority is the evolution of Copernicus Marine Service global and regional systems to better describe ocean phenomenon with high dynamics at fine spatial scales to provide enhanced boundary conditions to coastal models (both physics, biogeochemistry or marine ecosystems) thus strengthening the links with downstream coastal monitoring activities from the public or private sectors.

Mesoscale to sub-mesoscale features such as fronts, meanders, internal waves eddies and filaments, as well as turbulent mixing are of fundamental importance for the exchanges of heat, fresh water, CO₂, dissolved oxygen and nutrients between the surface and ocean interior, and in transition areas connecting the open ocean to coastal seas. The representation of tidal physics and wave-current interaction is also needed for a more complete representation of dynamical processes.

Small-scale dynamics is essential to better understand and represent ocean and climate interactions both for physics and biogeochemistry. Development of high-resolution global ocean models would also ultimately benefit to the development of higher resolution climate models needed for more skilful climate predictions.

The need for high-resolution global ocean models is also driven by the need for numerical models to develop a resolution capacity compliant with the spatial (and time) scales from present (Sentinels) and future EO satellites (e.g. wide-swath altimetry, geostationary sensors, surface currents).

Scope: Numerical codes shall be prepared to achieve smallest target effective resolution in the kilometric range constrained by high-resolution EO datasets. The following activities are required:

- Deliver global ocean analyses and forecasts at a kilometric scale with additional process complexity;
- Production of ocean forecasts and analyses that exploit upcoming HR satellite datasets;
- Develop advanced numerical schemes with improved accuracy and stability;
- Exploit the opportunities of new high performance computing (HPC) technology;
- Allow easy interfacing of the Copernicus service with local coastal models, allowing for two-way data exchange between coastal systems and the Copernicus Marine System;
- Assess the impact of solving the ocean dynamics at kilometric scales on the role of ocean on climate (e.g. vertical exchange of heat, representation of over flows);
- Assess the impact of solving the ocean dynamics at kilometric scales on the coupling with biogeochemistry and on the carbon, oxygen and nutrient cycles.
- Assess the adequacy and quality of satellite-derived ocean data into the coastal models, thus providing an opportunity for validation and integration with local ocean conditions.

A guidance document explaining the ongoing process to gather new user requirements is published together with this work programme⁶.

The Commission considers that proposals requesting a contribution from the EU of EUR 5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Building a low-carbon, climate resilient future".

Expected Impact: Expected outcomes should be to:

⁶ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

- Provide a significant contribution from the Science community to address the precedent list of unsolved issues related to a higher resolution of the ocean description;
- Deliver developments based on the NEMO ocean model to easily transition to the Copernicus operational environment as this world-class ocean model already forms the basis of the majority of analysis and forecast products;
- Prepare the necessary steps for further validation and integration into Copernicus and transition to operations;
- Identify priorities for next developments both in EO processing, in-situ contribution (additional data sources), assimilation and modelling capacities;
- Identify required coordination with other Copernicus services related to land, atmosphere or climate if so required;

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-SPACE-04-EO-2019: Copernicus evolution – Research activities in support of cross-cutting applications between Copernicus services

Specific Challenge: Copernicus produces a wealth of data and information regarding the Earth sub-systems (land, atmosphere, oceans) and cross-cutting processes (climate change, emergency and security). The wealth of information delivered by the Copernicus operational programme is not fixed but needs to evolve further with recognised and emerging user requirements and state of the art methodologies. The potential for new products and applications needs to be exploited, especially as regards cross-cutting cases not yet realised. A process has been set-up by the Entrusted Entities, together with the Copernicus User Forum and Copernicus Programme Committee, operating the core services to review the evolution of the services and any emerging adaptation needs as to their urgency, closeness to the operational delivery process, and availability of capacities. Specific and well-targeted applications involving the outcome from multiple core services need to be developed in the mid-term. R&D activities are to be conducted such that results are available in a sufficiently timely manner to support an informed discussion, if and under which conditions the proposed new applications should be integrated into the operational service portfolio of the Copernicus programme. Furthermore proposers should highlight where results could also be valuable for GEO, considering Copernicus as the European contribution to this global initiative.

Scope: Proposals shall demonstrate the technical operational feasibility of one specific cross-cutting thematic application. The proposers are expected to demonstrate that their proposal is relevant for the enhancement of Copernicus core services and capitalise from the corresponding product portfolio.

The output of this research and innovation action should provide a proof-of-concept or a prototype including a benchmarked selection of concurring methodological approaches, where feasible, that shall complement and broaden the panoply of information made currently available by the core services and which can act as reference for the independent assessment of Copernicus services evolution, in light of product extensions and service improvements.

These applications may concern areas in relation to domains such as energy, agriculture and forestry, health, water resources, security, natural environments and manmade disasters, resilience of built environment, cultural heritage, coastal monitoring, urban planning, climate adaptation, biodiversity and eco-system preservation, exploration and mineral resources, and others. Proposals are encouraged to use the Copernicus Data and Information Access Services (DIAS), or other existing data access solutions instead of setting up their own download and processing infrastructure. They are also encouraged to integrate third-party data (including in-situ data) and envisage data assimilation into models and products made available on the Copernicus platform of the Copernicus services..

The proof-of-concept or prototype should allow demonstrating the relevance and suitability to implement the proposed application later on at European level in a cost efficient manner, i.e. potentially with operational Copernicus funding. To allow a discussion of such potential operational funding, the activity should also result in one or more possible scenarios on how this application could potentially be integrated into the existing service architecture.

Proposers are invited to investigate synergies with the Knowledge and Innovation Communities (KICs), in particular Raw Materials and Climate⁷.

Proposers are advised to consult information on the Copernicus programme in general at <http://copernicus.eu>, the evolution topics identified there, the guidance document provided⁸ together with this work programme, as well as the availability of Copernicus Sentinel Data, access to Copernicus Contributing Mission data available via the Commission's website⁹.

The proposal should:

- Demonstrate to what extent the proposed evolution could be a candidate for the operational Copernicus service in terms of cost-benefits, calendar and operational feasibility;
- Specify the conditions for making available, for use and exploitation, the results (including IPR) to the entities implementing the EU Copernicus programme, including its contractors and service providers;
- Foster innovation and enhance applications which exploit Copernicus service information from across the service domain.

⁷ Please see further information on ongoing projects with KICs financed by the Copernicus programme at: <http://copernicus.eu/>; <https://eitrawmaterials.eu/eit-rm-academy/>; <http://eit.europa.eu/newsroom/eu-earth-observation-programme-copernicus-opens-its-database-worlds-largest-climate-action>

⁸ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

⁹ <http://www.copernicus.eu/main/data-access>

For proposals under this topic:

- Participation of industry, in particular SMEs, is encouraged;
- Coordination and partnership with KICs is encouraged;
- Involvement of post-graduate scientists, engineers and researchers is also encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Building a low-carbon, climate resilient future".

Expected Impact:

- Enable Copernicus services to better serve cross-cutting applications on European scale;
- Enhance European industry's potential to take advantage of emerging market opportunities and capacity to establish leadership in the field;
- Reinforce the link with academic and scientific sector for scientific exploitation of Copernicus data;
- Boost competitiveness of the industrial actors in EU and national procurements;

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-SPACE-05-EO-2019: Copernicus evolution –a gap analysis to prepare future activities for Copernicus data and information validation and quality enhancement

Specific Challenge: Copernicus is a European system for monitoring the Earth. Copernicus consists of a complex set of systems which collect data from multiple sources: earth observation [satellites](#) and [in situ sensors](#) such as ground stations, airborne and sea-borne sensors. The processed data are made available to the users as reliable and up-to-date information through a set of services related to environmental and security issues. The [services](#) address six thematic areas: land, marine, atmosphere, climate change, emergency management and security. They support a wide range of [applications](#), including environment protection, management of urban areas, regional and local planning, agriculture, forestry, fisheries, health, transport, climate change, sustainable development, civil protection and tourism.

A number of in-situ research infrastructures built by national or international programmes provide not only data of national interest, but also essential data for Copernicus. This is particularly true for observations done at global and European regional level. There is a need to develop mechanisms to help giving recognition to those observations by research infrastructures which support operational Copernicus services in meeting their objectives. In particular, in situ networks providing data for calibration and validation activities give a fundamental contribution to the Copernicus Services and the Copernicus Space component. It is therefore mandatory to map the requirements (type of measurements, geophysical parameters acquired, resolution in space and time, data uncertainty and quality, timeliness...) for in situ data and compare it to the existing observation system to find gaps.

The scope and potential of such contribution expands continually as research infrastructures evolve e.g. as European Research Infrastructures Consortium (ERICs), international partners gradually make their data available and as the relevance of no-space data is increasing in the context of Big Data applications.

Beyond the content generated by the infrastructures described above, most of them operate a bespoke and thus heterogenic IT infrastructure to collect, compute, store and distribute their data. Harmonisation and evolution initiatives are underway in the form of:

- the cloud infrastructures (EOSC) providing access to any type of data as well as virtually unlimited data processing and preservation capacity;
- the supercomputing facilities High Performance Computing (European Union HPC Strategy);
- the pan-European GÉANT network for scientific excellence, research, education and innovation already use by ESA and EUMETSAT to distribute a large portion of the data provided by the different contributing missions;
- the Copernicus Data and Information Access Services (DIAS) that offer access to Copernicus data and information alongside tools, storage and processing offerings.

At the same time there is also the need for a new, integrated and comprehensive Copernicus in-situ infrastructure which could be designed as an interface layer to make the collection of disparate observing networks (with different goals, methods, and governance) homogenously available to Copernicus users and operators in a cost-effective way.

The sustainability of in-situ observing systems remains a major concern, particularly at global and European level, and discontinued funding can pose a high risk for Copernicus.

There is a need to assess the current state of affairs in the areas described above and to propose a roadmap by establishing an inventory and performing an in-depth gap analyses in two main areas:

1. in-situ data and its use in Copernicus by looking in particular at identified areas where the operational Copernicus data and information provision could be improved;

2. On the basis of the work under 1, and taking into account the already ongoing initiatives in the IT domain, the areas where additional adaptations or additions to the currently implemented IT infrastructures would be needed or beneficial to facilitate the use of the related data within Copernicus.

Scope: The main purpose of this action is to devise a sustainable and cost effective Copernicus products validation framework capable of meeting present and future requirements for data and information validation and quality enhancement delivered by Copernicus services and Space Component.

The proposal should take into account the on-going activities in the Copernicus in-situ component with the European Environmental Agency (EEA) as the Entity entrusted by the European Commission to coordinate and develop this fundamental Copernicus component¹⁰.

The scope of this call encompasses the following steps:

1. Establish a complete inventory of the current and foreseen (when possible) use of in-situ data by the entities entrusted with the production and distribution of Copernicus data and information with a clear identification of the available and accessible in-situ and research data sources in Europe (at national, European or international level) and in the current and future non-European partner countries for Copernicus (US, Australia, South America, Africa, India).
2. Perform a gap analysis mapping the Copernicus needs versus the in-situ observations for the following activities:
 - o sensor calibration (including vicarious calibration), algorithm calibration and products validation (mainly level 2 data) for the Copernicus space component, Sentinel and essential missions¹¹, present and future;
 - o products validation for the Copernicus Services;
 - o cross-cutting multi purposes products validation, not tailored on specific service or component.
3. Gaps shall be characterised as a minimum by identifying:
 - o Missing data (completely or partially);
 - o Data accuracy and uncertainty;

¹⁰

<https://insitu.copernicus.eu/library/reports/ResearchInfrastructuresandCopernicusFinalversionNov2017.pdf>

¹¹ <https://insitu.copernicus.eu/library/reports/state-of-play-report-observations-december-2017-2>
Essential missions are the ones with a well-known and demonstrated involvement in the services production chains: the actual involvement should be demonstrated in the proposal.

- o Procedural issues (such as delivery delay, obsolescence of the infrastructure, lower quality of data, automatic processing, standardization and coordination with Copernicus services).
4. For the identified in-situ infrastructures the following points should be analysed to help reveal any existing gaps:
- o the maturity level and missing steps to become operational for Copernicus (e.g. new design, pure research, pre-operational) and the priorities due to their impact on Copernicus;
 - o the sustainability of the existing observations, update of observing infrastructure to cover missed parameters and improve the accuracy of the measurements and the IT specific needs e.g. connection to get the data, tools to exploit and process them, distributing data and products taking into account the already existing activities or projects like EOSC, HPC, GEANT and DIAS;
 - o Related ongoing projects (H2020, ESA, JRC, EEA...) and their respective budget(s) when available.
5. Propose a priority list of elements to be addressed and a set of related research roadmaps that allow addressing the identified gaps. This should include relevant interdependencies between research areas, such as:
- o Research into expansion of in-situ networks or improved in-situ data accuracy and quality, formats etc. to sustain and improve the Copernicus data and information veracity and accuracy;
 - o Research into potential expansion of Copernicus and Copernicus-derived services building on additional in-situ resources and non-environmental data;
 - o To propose a potential evolution of existing infrastructures as a Copernicus interface layer to make the collection of disparate observing networks homogeneously available and accessible to the Copernicus users and operators;
 - o Propose a detailed roadmap for the implementation of the Copernicus interface layer considering the different starting level: e.g. transition, new research, research to make them operational etc.

Proposals are expected to integrate relevant and knowledgeable actors from at least the four core domains covered by this topic:

1. Copernicus services
2. Copernicus space data providers
3. In-situ national and European (research-) infrastructures

4. European e-infrastructures

For proposals under this topic:

- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate scientists, engineers and researchers is also encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU in the range of EUR 2 million would allow this specific challenge to be addressed appropriately. Nevertheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- To complete a comprehensive overview of the status of research infrastructures already used by Copernicus;
- To enable the identified research infrastructures to better respond to Copernicus operational needs;
- To enable the identify missed in situ observation required to improve the accuracy of the satellite Copernicus products and monitor their quality in operation;
- Reinforce the cooperation among different Copernicus actors (entrusted entities, space data providers, in-situ data providers and research infrastructures) on the in-situ data network.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

DT-SPACE-06-EO-2019: International Cooperation Copernicus – Designing EO downstream applications with international partners

Specific Challenge: Copernicus, the Union's Earth observation and monitoring programme produces a wealth of data and information regarding the Earth sub-systems (land, atmosphere, oceans) and cross-cutting processes (climate change, emergency and security). Cooperation with international partners is key to promoting the uptake of Copernicus globally, exploiting possibilities for integrating in-situ, space data and information technologies. Building the Copernicus full, free and open data policy, the Commission seeks to facilitate access to Copernicus data and information for interested international partners. Administrative cooperation arrangements on Copernicus data access and earth observation data exchange have already been signed with the United States and Australia, and discussions towards

similar cooperation have been started with other countries and regions (including Africa, Latin American countries and Asia-Pacific countries).

Cooperation with partner countries should be fostered with a view to using Copernicus data to jointly develop algorithms, services and/or products which serve local user needs and/or enhance the Copernicus global product quality.

Proposals are encouraged to use the Copernicus Data and Information Access Services (DIAS), or other existing data access solutions instead of setting up their own download and processing infrastructure. They are also encouraged to integrate third-party data (including in-situ data) and envisage data assimilation into models and products made available on the Copernicus platform of the Copernicus services..

For such applications and developments to succeed in the market or with public users, the products need to be shaped according to users' needs and their value to users must be openly demonstrated to the wider user community. This needs to be achieved in an environment integrated at the level of the user, in order for users to accept the innovative potential which the product promises. This will require also specific attention to be given to the various processes in place in the users' workflows which incorporate the EO information. Furthermore, the transition of R&D product prototypes to viable commercial product lines after the end of the EU funded phase remains a challenge to be addressed early on during product development.

Scope: Proposals shall address a wide variety of applications stemming from the use of Earth observation and their smart integration with other related technologies. Copernicus should be considered as part of the solution which may include other space or non-space inputs. This is likely to lead to greater value, opportunities and especially market uptake. Applications shall be sustained by a production process capable of delivering to the user a product which is validated and accepted as a marketable product in the international partner country. International collaboration has a key role to play in this context, as it enhances access to markets beyond the national borders, notably by enabling space application providers to absorb market-related tacit knowledge and know-how of their partners. Corresponding validations and customisations are to be undertaken, and the business case for the application is to be demonstrated. Service level models are to be developed, with appropriate quality of service definitions for the application. Application products are expected to adopt open standards for data documentation, data models and services including data processing, visualisation and cataloguing on a large scale.

Tasks shall include joint calibration and validation activities or integration of local in-situ systems to enhance the quality of data and service products. It is important to exploit the added value of integration of EO observation technologies (both satellite, airborne and ground based) with positioning ones, and ICT (enhancing new frontiers opened by cloud computing) from international partner countries through the development of applications, and encourage their insertion into the market.

The choice of EO application is left to the proposer.

Applicants are advised to consult further information on the availability of Copernicus Sentinel Data, access to Copernicus Contributing Mission data, as well as issues recommended to be detailed in the proposals via the Commission's Copernicus website¹².

For proposals under this topic:

- Participation of at least one partner from a country that has signed a Copernicus Cooperation Arrangement¹³ is required;
- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate scientists, engineers and researchers is encouraged, for example through professional work experience or through fellowships/scholarships as applicable;
- Participation of partners involved in international GEO initiatives is encouraged.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 2 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Digitising and transforming European industry and services".

Expected Impact:

- Establish sustainable supply chains for innovative EO value added products and services with demonstrated commercial value with international client communities;
- Complete integration, based on international standards, into the customer's existing business processes and processing chains, as well as the economic viability of the application is to be demonstrated;
- Enhance the European industry's potential to take advantage of market opportunities and establish leadership in the field and to boost business activity;
- Lead to new or improved products, processes or services on the market that are capable of generating within 3 years after the end of public funding a significant turnover for the participants, and create new jobs;
- Lead to an improved quality of the Copernicus global product, thereby enhancing the stating of Copernicus data and information in a global environment and GEOSS.

Type of Action: Research and Innovation action

¹² <http://www.copernicus.eu/main/data-access>

¹³ See Copernicus.eu for list of countries concerned

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-SPACE-18-EO-2020: Copernicus evolution: Research activities in support of the evolution of the Copernicus services

Specific Challenge: Copernicus operational services are not static, but need to evolve with recognised and emerging user requirements and EU policies.

R&D activities which are suitable for this call are identified to this end by the Commission, together with the Entrusted Entities, for each service. The challenge is to clearly demonstrate if and under which conditions an evolution of the operational service portfolio is appropriate and in line with the Copernicus Programme.

Scope: The proposal should tackle only one of the following sub-topics. For the chosen sub-topic the proposal should clearly identify one (or more) core product(s) to be developed as a completely new or improved product.

The Commission, together with the Entrusted Entities, has identified for each service (sub-topic) the areas of Copernicus R&D interests:

1. Copernicus Emergency Monitoring Service (CEMS): resilience to climate risk, population exposure risk (e.g. in coastal areas, flood prone areas, areas exposed to droughts...). The proposed activities need to consider the existing CEMS framework and describe how they can contribute to a fully integrated risk cycle monitoring service
2. Copernicus Monitoring Atmosphere Service (CAMS): Up-to-date emissions of reactive gases and aerosol based on inverse modelling, Improve atmosphere monitoring using data assimilation and preparation for upcoming sentinels (with a focus on Sentinel-4), Integrated soil-vegetation-atmosphere modelling and data assimilation for representing emission and deposition of atmospheric pollutants.
3. Copernicus Climate Change Service (C3S): exploitation of seasonal forecasting systems as natural integrator of Copernicus Services, enhancement of predictive skills at seasonal timescales, consistent climate re-analysis of the Earth system, improvement in predicting variations of the climate system over the next few years and decades, linkages between current extreme weather events such as droughts, heat waves or floods to anthropogenic climate change and/or natural climate variability.
4. Copernicus Marine Environmental Monitoring Service (CMEMS): Advanced marine data assimilation techniques for physics (e.g. ensemble methods, assimilation of future satellite observations like swath altimetry and surface currents), improvement of biogeochemical products for the carbon cycle (CO₂ ocean component), water quality and food security (food web modelling, habitats), with assimilation of satellite and in-situ data, improved biogeochemical models, coupled physics and biogeochemistry models and use of new in-situ observations (e.g. BGC Argo) to validate biogeochemical models.

5. Copernicus Land Monitoring Service (CLMS): essential ecosystem variables for natural capital accounting, HRL for agriculture, forest and urban monitoring, CLC+, environmental compliance, support to sustainable development goals, exploitation of mid and high resolution satellite combination for continuous environmental change monitoring.
6. Security New concepts for applications based on the integration of relevant information derived from space or non-space sources, current services or other value-added applications, targeted to support civil protection and security. New algorithms for automated monitoring and detection of changes and patterns of life. Those activities should also aim at bridging the gap between demand and supply, complementing the offer of the Copernicus Security services and enlarging its user base.

Actions should take into account the existing portfolio of the services and clearly define to what extent main model, algorithm, tool and technique should be improved to generate new or better products.

Actions aim at demonstrating the technical operational feasibility of the selected product(s).

The proposed development should be modular and scalable. The project should provide a proof-of-concept or a prototype (e.g. system element) demonstrating the feasibility of the integration in the existing core service. This new “system element” should also guarantee the expandability required for the integration of new data from potential space or no-space new mission/sensors.

During the development of the project, the team taking into account the delineation between Copernicus core services and downstream services, should clearly identify the right context of the proposed product(s). The border delineation takes into account the principles of subsidiarity and proportionality, the avoidance of duplication, and the facilitation of user uptake.

The proposal should also investigate to what extent the proposed evolution could be a candidate for the operational Copernicus service in terms of cost-benefits, calendar and operational feasibility.

R&D activities should aim at a better integration of space research with other non-space domains (e.g citizen science including social media) focusing in particular on policy areas addressing global and societal challenges highlighting horizontal synergies and multidisciplinary approaches. In particular, proposals should clearly mention which of the UN Sustainable Development Goals the project will support.

New IT tools should be considered and innovative solutions should be proposed for a better data exploitation, processing and distribution, e.g.: cloud and HPC computing, distributed computing, Artificial Intelligence, machine learning (e.g. for automatic feature recognition), ensemble modelling, model coupling & nesting, software as-a-service.

Additionally, the operationalisation of the research results should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-use and exploit the results (including IPR) to the entities implementing the EU Copernicus programme. The software should be open licensed in order to use, copy, study, and change it in any way.

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en>, the availability of Copernicus Sentinel Data, access to Copernicus Contributing Mission data at the Commission's website (<https://www.copernicus.eu/en/access-data>).

It should be noted that funding of the H2020 project in no way commits the Commission or the Copernicus service operators to deploy the outcomes from the research in the Copernicus operational services.

For proposals under this topic:

- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate scientists, engineers and researchers and promotion of gender balance is also encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

At least one proposal per sub-topic shall be selected for funding.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 1.5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Increased coverage of EU policies, clearly identifying which and how the project intends to address them;
- Integration of different observation capacities with a clear demonstration of an increase in the service performance (compared with the existing one);
- The proposed proof-of-concept or prototype, as outcome of the project, should clearly demonstrate an improvement of the Copernicus service evolution.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-SPACE-19-EO-2020: Copernicus evolution: new concept for an innovative and holistic solution for Sentinels calibration & validation

Specific Challenge: Copernicus is addressing all domains of the Earth environment, including the atmosphere, the land (including inland waters) and the oceans. The EU environmental programme Copernicus implements six services that benefit significantly from measurements acquired by EO satellites, the so-called Sentinels series. The first generation of Sentinels includes 6 families of satellites (from S1 to S6), each family having 4 members (from A to D) and additional satellites providing complementary measurements to the existing fleet are foreseen in the context of the expansion of the Copernicus programme.

The utility of the large and growing volume of satellite observations and derived data products for operational services is crucially dependent on the proper calibration of the instruments and validation of the products. Global monitoring over extended periods is expected to require even more rigorous inter-calibration in the future.

These routine calibration/validation (cal/val) exercises are required in order to relate the space measurements to internationally recognized standards to ease comparability of satellite measurements taken at different times and locations, by different instruments and to facilitate cross-validation with other types of measurements and model output.

Cal/val activities are a fundamental aspect of the entire Copernicus programme as the essential connection between Space Component, in-situ Component and Services. Data sharing and data exchange principles and processes should be well defined and promoted by the Programme.

The dimension and breadth of such an operational programme calls for a commensurate instrumental support to perform the required cal/val procedures. Such procedures are currently implemented through existing infrastructures, which are strictly tied to individual missions, set up in an ad hoc manner by different agencies and institutions to provide the basic needed support.

The lack of sustainability in the maintenance of the calibration and validation infrastructures is clearly not in balance with the dimension of the Copernicus space component and its ambitions for evolution in future. Often there is a strong dependency on research infrastructures which is not fit-for purpose in the context of an operational Programme such as Copernicus.

Moreover, the lack of sustainability goes along with a lack of a holistic approach, e.g., a minimum set of standard instruments to be operated through optimised sites or "supersites", which would in addition enable an economy of scale. Such "supersites" of fiducial reference measurements may have to be domain specific to cover various geophysical media, but also across domains as the case for the atmosphere in particular. Many issues are at stake when setting up a ground-based network of fiducial reference measurements including the need for optimization depending on the foreseen applications.

Scope: The action should define an innovative and holistic strategy for the cal/val activities for and across all existing and planned Sentinels in an operational perspective to better access to the necessary infrastructure for Fiducial Reference Measurements.

A number of specific questions need to be addressed:

1. The clear identification of cross-Sentinels calibration requirements (from level 0 to level 1 data) and of validation requirements (from level 1 to level 2 data).
2. The clear identification of different cal/val sources: e.g. other satellites, on board calibration, in situ networks, regular airborne campaign, ad hoc site characterization with an overview of existing relevant networks, their distribution and current resourcing.
3. The comparative evaluation of various methodologies including those which are operational and those which are in a pre-operational status, evaluation of the steps needed to bring the latter to an operational level.
4. The project should design a comprehensive operational approach for medium and long term cal/val strategy for and across all existing and planned Sentinels with a particular focus on:
 - a. The definition of appropriate reference networks and gap analysis with respect to existing ones, an assessment of the sustainability and operational status of the existing networks, an assessment of "interoperability" needs between networks;
 - b. The definition of the characteristics and the location of optimised sites or "Sentinel supersite(s)", or where necessary of supersite definition per domain (land, atmosphere and ocean);
 - c. An evaluation of the direct impact on level 3 products when relevant;
 - d. A proposed solution that should be modular and expandable in light of the potential future Sentinels in the context of the Copernicus evolution.
5. The linkage between EU and non-EU aspects of the networks needs and identifying the necessary non-EU partnerships to prioritise.
6. The definition of a long-term strategic reference scenario for the implementation of the required infrastructure.

Efforts should be made to establish counterparts and strong linkages with the international community working on issues relating to Calibration and Validation, in particular with the European Space Agency and EUMETSAT and established standards in place through the CEOS Working Group on Cal/Val and Quality Assurance for Earth Observation framework (QA4EO) as well as the operational elements in place through the WMO Global Space-based Inter-calibration System (GSICS).

The project should take into account relevant on-going coordination activities performed by the European Environment Agency (EEA) as the Entity entrusted by the European Commission to coordinate activities within the Copernicus In Situ component.

The project should also propose recommendations and establish a roadmap to develop this innovative “Sentinels cal/val concept” with specific reference to the “Copernicus supersite(s)” definition and their distribution, including considerations on data quality check, harmonization, traceability, distribution and conservation process of related information.

For proposals under this topic:

- Involvement of post-graduate scientists, engineers and researchers and promotion of gender balance is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of EUR 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Consistent approach for the calibration and validation for and across Copernicus Sentinels
- Coordination of networks and space agencies and institutions contributing to Copernicus Sentinels cal/val activities

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

LC-SPACE-24-EO-2020: Copernicus evolution: Mission exploitation concept for WATER

Specific Challenge: In the frame of the space strategy and with the willingness to ensure the sustainability and the development of an enhanced capacity for the evolution of the Copernicus programme, several mission concepts are developed to support areas such as agriculture, forest, water resources, climate change, or polar challenges. In addition, the design and evolution of the current generation of Sentinels will have to be prepared to ensure the enhanced continuity of the current Copernicus services. Existing and planned space component capacities will be also potentially available in terms of contributing missions.

Data and product information related to water and hydrological / hydrodynamic processes are already developed or used in several Copernicus services: the global land service, the pan-European and local land service, the emergency service, the climate and the marine monitoring service. Their developments are performed separately and in the specific purpose

of each service without considering the global understanding and better representation of the water cycle from regional to global scale.

Additionally, the user requirements process undertaken by the European Commission has also identified many requirements on data and products to water issues (in a broader sense: from water reservoirs to rain, river runoffs, ice or water in soil and groundwater) to support many policies areas: the EU Water Policy - Framework Directive (2000), the Bathing Water Directive (2006), the Flood Risk Directive (2007), but also indirect support to policies related to the Agriculture, inland transport, food security, energy and hydropower that commonly focus on a local-regional scale. The efforts made at international level for water management should also be taken into account, including the UN Water coordination mechanism and the World Bank Water Partnerships. The Sustainable Development Goal no.6 (Clean Water and Sanitation) ensuring availability and sustainable management of water and sanitation is fully embedded into this international context.

Those requirements can only be fulfilled by addressing all issues relating to the global water cycle. The coordination and integration of the water monitoring approach should be improved inside the Copernicus land service and along all the other services. The portfolio should be reinforced with the view of monitoring with a better consistency inland waters on and beneath the Earth surface (mapping water storage and water transport processes, as well as hydrodynamic processes, water quality, hydrological cycle, connection with ocean processes, ...) providing a real support to policy actors and to decision-makers.

The development, the implementation and eventually the operation of an enhanced European space capacity including possible innovative expansion missions and the enhanced continuity of Sentinels is an opportunity to better address this crosscutting issue.

It will need the involvement of various players: such as National Space Agencies, European and Member States Institutions (e.g Member States' Water Authorities), International Organisations, the private sector, operators of in-situ measurement stations, and of leading scientific experts in the identified fields such imagery processing, aquatic optics, data fusion and data assimilation of in-situ measurement stations and networks and hydrological / hydrodynamic modelling for different water storage and flux components.

Initiating and consolidating the establishment of this community and thus reaching the critical mass required for addressing such a challenge will need to take into account:

- The catalogue of products in the Land component of Copernicus (i.e. High resolution layers with water and wetness layers, riparian areas, water products from the global land service at EU and global scale...);
- Current and planned activities led by the Copernicus Programme (space component and services, i.e. land, emergency, climate, marine) for future services;
- The relevant H2020 and ESA projects.

Scope: The main goal is to analyse current and planned EO space capacities together with innovative processing, modelling and computing techniques to reinforce the existing portfolio offered under Copernicus and to propose an integrated approach for a coherent and consistent inland water monitoring system.

A specific attention should be paid to Copernicus core services providing an economy of scale at EU level, how to avoid also duplication of effort between the six services and to support and benefit from the innovation power of the market driven the industry. Through this Copernicus evolution action, specific elements should be addressed:

- improved quality of inland water variables with remote sensing at high and very high resolution (spatial, temporal and radiometric) considering specific pre-processing cloud screening and atmospheric correction, providing objective harmonized measured over different water (e.g. with gradients of trophic status, optical properties), water storage and flux components types with methods from regional to global applicability, building on a multi-sensor and sensor-independent approach to retrieve seamless and gap-filled products;
- development of high level biogeochemical products, beyond basic variables for water quality and food web modelling or analysis;
- development of mixed EO / model approach leading to enhanced key variables with hindcast and forecast features, continuity of altimetry water-levels and water storage consistent between land and ocean, integrative approach of water at atmosphere (e.g. precipitation) combined with land and ocean, water hydrological cycle and its hydrodynamics provided seamlessly along the hydrographic networks, lakes and rivers including the transition from land to ocean;
- Development of temporal and change detection approaches based on the analysis of existing times series of satellite observations of inland waters, including water availability, water quality, water storage, water fluxes, temperature, ice conditions of rivers, lakes, basins and coastal areas, including socio-economic data of the catchment area;
- Development of innovative methodologies for uncertainties characterisation (including in-situ data and crowd sourcing).

This should result in the assessment, for the long term, of the best mission concept for water with expected performances, combining existing, next generation and expansion missions under study plus in-situ or non-space observation capacities.

Activities should coordinate ongoing efforts, include mutual identification of research and infrastructural gaps, identify a clear delineation between a core service and a downstream application and facilitate a cooperation of further research and development to be undertaken to reach sufficiently mature capacities for an operational integration as a subsequent step.

The coherence between the space component and the service related requirements should be ensured.

For proposals under this topic:

- Involvement of post-graduate scientists, engineers and researchers and promotion of gender balance is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of EUR 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Increased coverage of EU policies clearly identifying which and how the project would like to address them;
- Based on Copernicus services and existing and future Copernicus missions, define a scenario with the use of new operational capacities and to improve the interactions with non-EO communities on the inland water domain.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Artificial Intelligence and Space

The adoption of Big Data technologies and AI in the space industry represents a significant opportunity to innovate. Handling large volumes of Copernicus Earth observation data and intelligent image analysis support are two examples.

Proposals are invited against the following topic(s):

DT-SPACE-25-EO-2020: Big data technologies and Artificial Intelligence for Copernicus

Specific Challenge: Copernicus is producing increasingly large data volumes that require specific Big Data technologies and Artificial Intelligence (AI) methods to analyse it and manage it.

The adoption of Big Data technologies in the space industry represents a significant opportunity to innovate. As an example, performance and/or automation of processes can benefit and greatly improve the capabilities to deliver timely services.

In addition, solving the big data management challenges of the integration, processing and analysis of Copernicus data with other distributed data sources from other industrial domains

other than Space will open up new market avenues and strengthen European leadership in earth observation applications and technologies.

Copernicus' data and applications are part of the European Data Economy and its value chains. As such, this call is promoting the collaboration of ICT actors, both from industry and academia, with the earth observation/space stakeholders.

Scope: Development of big data technologies and analytics, and AI methodologies addressing industrial requirements and/or societal challenges with Copernicus' earth observation data at their core, scaling up to the increased data volumes of Copernicus' archives. They shall aim to develop new, enabling, operational solutions to improve capabilities and performance of the Copernicus value chain: from access and discovery of data and information to integration with other data sources and analysis to delivery and applications. Proposals can address individual elements of the value chain or the value chain as a whole, and should provide quantitative measures of the progress beyond the state of the art.

Proposals are also required to seek end user involvement to drive the research with their requirements and test the developed solutions, with a clear path to the exploitation of the results.

Proposals are strongly encouraged to make use of existing European data infrastructures such as (but not limited to) Copernicus' DIAS and to develop solutions that can be plugged into DIAS and/or other existing European data infrastructures to enhance their capabilities and offer.

Whenever relevant, proposals are invited to explore the synergies with EGNOS/Galileo signals and services.

The "other distributed data sources" should be available to the project and described in the proposal.

For proposals under this topic:

- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate scientists, engineers and researchers and promotion of gender balance is also encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 4 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Increased capacity of processing and analysing large volumes of Copernicus earth observation data, with powerful tools that demonstrate their applicability in real-world settings;
- Increased performance and/or automation of processes involving the processing of Copernicus data;
- Enhanced, innovative applications to support the Copernicus DIAS platforms;
- Demonstrated adoption of results of the Copernicus data analysis in decision-making (in industry and/or society).

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Space business, entrepreneurship, outreach and education

Space start-ups in Europe are faced with a great difficulty in accessing finance including risk-capital. Moreover, despite their high technical skills, start-ups in Europe are lagging behind when it comes to business expertise.

The emergence of a business- and innovation-friendly ecosystem needs to be supported at European, regional and national levels. This could be promoted through network hubs that bring together the space, digital and user sectors. The objective is to open up space to non-space entrants, including: i) innovative European ICT entrepreneurs and user sectors (such as energy, transport and others building on existing clusters or hubs), ii) ESA's space solutions and iii) initiatives in the Member States (e.g. innovation clusters, boosters). There should be support for the exchange of best practices and common specifications, and capacity building maximising benefits for all Member States.

Support for SMEs, start-ups and young entrepreneurs should be stepped up and coordinated with efforts launched by business incubators as well as prizes and competitions, such as the Copernicus and Galileo Masters.

With a view to supporting commercialisation, access to finance for space in the context of the Investment Plan for Europe and Union funding programmes¹⁴ should be promoted. The Investment Plan for Europe, in particular through its European Fund for Strategic Investment, can play an important role in supporting innovative projects. Thematic finance for space entrepreneurship mainly by means of equity (e.g. venture capital, business angels) could help foster such an approach and shall take in due consideration the need for enhanced support of the downstream space sector.

¹⁴ Notably Horizon 2020, COSME, the European Structural Investment Funds.

Awareness-raising and outreach activities should also be multiplied, notably at local and regional levels, to inform the industry, including SMEs, and financial intermediaries about the business opportunities offered by Union initiatives and programmes.

To maintain and further strengthen Europe's world-class capacity to conceive, develop, launch, operate and exploit space systems. To ensure this, there is need for support to competitiveness of the whole supply chain and actors from industry to research organisations based on the following three pillars: a) fostering the emergence of an entrepreneurial ecosystem, b) opening up new sources of financing, c) encouraging awareness-raising and outreach activities about new business opportunities and making sure this will benefit businesses in all Member States.

Activities shall be in synergy with user uptake actions launched under Copernicus and with the ESA Space Solutions.

Proposals are invited against the following topic(s):

DT-SPACE-07-BIZ-2018: Space hubs for Copernicus

Specific Challenge: The Commission has identified the need to support the creation of voluntary participative networks related to Earth observation and Copernicus. The Copernicus Relays and Academy have been set up under their own funding and act as channels of promotion and target, targeting intermediate and end-user communities.

The Commission does not finance the members of the Copernicus Relays and Academy directly. The Commission finances:

- The Copernicus Support Office, which provides non-financial support to members of the two networks (e.g. speakers, advice, promotional material);
- The Copernicus User Uptake Framework Partnership Agreement, through which the Commission co-finances user uptake activities with Member States. Some of these activities might be organised by members of the Copernicus Relays or Academy, but will focus exclusively on stimulating the use of Copernicus data and information (e.g. awareness events, booths).

The Commission wishes to provide financial support to these two networks in order to strengthen their R&D dimension. These networks need to be better linked with research and innovation activities and with the ESA Space Solutions. Moreover, the expertise and tools developed by the Copernicus Relays and the Copernicus Academy need to be used also at the service of research and innovation with a view to boosting their innovation potential: and the uptake of space in general.

Scope: Support the activities of the Copernicus Relays and the Copernicus Academy by:

- Organising joint initiatives of interest to the network and its members, such as events and educational opportunities;

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- Sharing communication tools to ensure updates about the latest Copernicus events, lectures, new members, new training tools, best practices, and new funding opportunities;
- Develop publications and reference lectures for training on Copernicus data and information use, under a public license and Including Copernicus-related material and modules in existing courses;
- Fostering user uptake and spin-off strategies of the members, notably by interacting with the Copernicus entrusted entities, Copernicus partners and local actors;
- Supporting the organisation of events and initiatives at local level to promote Copernicus to potential users.

Proposals shall demonstrate that they avoid overlap with the various activities financed under Copernicus, such as the Copernicus support office and Copernicus User Uptake Framework Partnership Agreement.

The Commission considers that proposals requesting a contribution from the EU of EUR 1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Digitising and transforming European industry and services".

Expected Impact:

- Strengthen the synergies and cooperation between members by sharing knowledge building, education experiences, best practices and Copernicus-related research and applications outcome and by enabling developed innovations to 'hit the market' as quickly as possible;
- Build up a knowledge culture and a strategic think-tank around the benefits of the Copernicus programme and its potential for both public services needs and societal challenges;
- Increase awareness about Copernicus toward all potential user communities.
- Expand these two networks to other European Regions and to other space technologies (e.g. Galileo) and activities from other major space and innovation actors (such as those of regional clusters, national space agencies and the ESA).

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

DT-SPACE-08-BIZ-2018: Space outreach and education

Specific Challenge: One of the main challenges for the sustainability of the European space industrial fabric and the delivery of cutting-edge scientific achievements is to maintain highly qualified scientists, engineers and technicians including their lifelong learning. Space science and technology constitute important inspirational tools for exciting and motivating young people, and encouraging them to choose space related careers. Space is also a domain that easily captures the interest of students towards education paths in the fields of science, technology, engineering and mathematics.

Positive exposure to and experiences in the space domain can contribute moreover to building long-term partnerships between peoples from different cultural backgrounds and countries inside and outside Europe. The challenge is to design and run sustainable education and outreach activities which can act as catalysers, both inside and outside the classroom, motivating teachers and students at different ages and education levels.

Scope: The main delivery of the action shall be an initiative capable of attracting the interest of a significant number of students towards space and space-related themes, while creating at the same time a relevant impact on their families and the general public in terms of news coverage, social-media interest, stakeholders' involvement. The action shall engage academia and educators involved in different education levels, targeting different demographics including young children and teenagers.

The key advancements of the European space programmes should be given a privileged position, but the main objective should remain attracting the interest of students for space, space-related subjects and steer them towards education paths in the fields of science, technology, engineering and mathematics.

Proposals should take into account similar activities of ESA and national education programmes. They could focus in the context of the classroom or outside the normal classroom environment, making use of space educational centres or online resources, including contests and public exhibitions (for instance in science museums). Particular attention should be paid to stimulating interest amongst female students and reaching children in underprivileged communities.

Activities shall also aim at identifying links with the Knowledge and Innovation Communities (KICs) of the European Innovation Institute of Technology (EIT) and possible scope for dedicated activities for space.

The Commission considers that proposals requesting a contribution from the EU of EUR 1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Digitising and transforming European industry and services".

Expected Impact:

- Promote the network European space education and outreach actors and reach out to a significant number of students, their families and the general public.
- Achieve a significant coverage by media and attention by stakeholders and help increase the political support for European space programmes and initiatives within the EU and national Parliaments.
- Increase the number of students that opt for a technical career related to space when compared to the general population of students in their cohorts;
- Promote research in collaboration with universities.
- Reinforce links between space and the EIT KICs and explore options for a dedicated space KIC.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

DT-SPACE-09-BIZ-2019: Space hubs (support to start-ups)

Specific Challenge: The challenge is to increase the number of initiatives for start-ups, scale-ups and entrepreneurs in the space downstream and upstream sectors (such as Incubators, Accelerators, Hackathons or AppCamps), provide solutions to accelerate the growth of space scale-ups and the commercialisation of their products, engage small and medium enterprises in space innovation, especially those not traditionally involved in it, and reduce as much as possible the entry barriers to SMEs for Horizon 2020 to develop space-enabled solutions.

Scope: To organise effective initiatives at local level for:

-support start-ups, scale-ups and entrepreneurs in the areas of applications, especially in connection to Galileo and Copernicus (although not exclusively),

-spinning-in/-out (i.e. application of marine, atmosphere and terrestrial solutions to challenges in space and vice versa) and solutions in support of the commercialisation of space.

Initiatives shall be complementary to the actions developed at EU level (such as the SME Instrument, Copernicus and Galileo Masters, Copernicus Accelerator, Copernicus Incubation Programme, European Institute of Technology (EIT) Knowledge and Innovation Communities (KICs)) and should aim to build bridges between local and European initiatives.

They shall also integrate training/raise awareness on the data, information, resources and tools available within the DIAS environments and embrace best practices from these environments, as an enabling element in support of the development and scaling-up of start-ups.

The Commission considers that proposals requesting a contribution from the EU of EUR 1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Digitising and transforming European industry and services".

Expected Impact:

- Generation of new initiatives at local level (such as Incubators, Accelerators, Hackathons, Appcamps) complementing those at EU level;
- Creation of new start-ups and applications notably through awareness raising activities and initiatives to facilitate technology transfer;
- Generation of new services oriented solutions allowing innovative financial support frames;
- Growth of the number of start-ups in Europe;
- Growth of scale-ups in Europe;
- Increase the commercialisation of scalable and cost-efficient solutions.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

DT-SPACE-26-BIZ-2020: Space hubs (support to start-ups)

Specific Challenge: The challenge is to increase the number of initiatives for start-ups, scale-ups and entrepreneurs in the space downstream and upstream sectors (such as Incubators, Accelerators, Hackathons or AppCamps), provide solutions to accelerate the growth of space scale-ups and the commercialisation of their products, engage small and medium enterprises in space innovation, especially those not traditionally involved in it, and reduce as much as possible the technical and financial entry barriers to SMEs for Horizon 2020 to develop or adopt space-enabled solutions.

Scope: To organise effective and sustainable initiatives at European level for:

- supporting start-ups, scale-ups and entrepreneurs in the areas of applications, notably with regard to EGNOS/Galileo and Copernicus;
- spinning-in/-out and solutions in support of the commercialisation of space.

Actions should be complementary to other actions developed at EU level (such as the European Innovation Council pilot, Copernicus and Galileo Masters, Copernicus Accelerator, Copernicus and Galileo Incubation initiatives, European Institute of Technology (EIT)

Knowledge and Innovation Communities (KICs)) and should aim to build bridges between local and European initiatives.

Actions implemented under this topic should also support start-ups, scale-ups and entrepreneurs in accessing finance, as well as blended funding to enhance financial sustainability and viability of businesses within the space sector.

Actions should, moreover, support the work of the Copernicus Academy.

They should also integrate training/raise awareness on the data, information, resources and tools available within the DIAS and embrace best practices from these environments, as an enabling element in support of the development and scaling-up of start-ups.

The Commission considers that proposals requesting a contribution from the EU of EUR 1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Generation of new initiatives at local level (such as Incubators, Accelerators, Hackathons, Appcamps) complementing those at EU level;
- Creation of new start-ups and applications notably through awareness raising activities and initiatives to facilitate technology transfer;
- Generation of new services oriented solutions allowing innovative financial support frames;
- Growth of scale-ups in Europe;
- Increased access to finance and funding opportunities;
- Enhanced financial sustainability of start-ups and scale-ups;
- Increased survival rates of start-ups;
- Increased commercialisation of scalable and cost-efficient solutions.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Space technologies, science and exploration

Support to generic and mission-oriented R&D technology at low and mid TRL levels is important for addressing non-dependence and competitiveness of the European Space industry. Generic technology development allows longer-term, innovative and breakthrough technologies to emerge. IOD/IOV (in-orbit-demonstration/validation) addresses mission specific or application-oriented needs and permit industries to mature marketable products.

On the low TRL side, support for future and emerging space technologies are expected to initiate new lines of disruptive technologies through collaborations between advanced multidisciplinary science and cutting-edge engineering often involving innovative SMEs. This will turn the excellent science base of Europe into a competitive advantage by establishing early stage European leadership in promising future space technology areas that would be capable of renewing the basis for future European competitiveness and growth.

The COM-ESA-EDA Joint Task Force process on critical space technologies ensuring European non-dependence is well-established and valued by stakeholders. The updated list of actions should be the basis for the work programme in this area.

Mission or application oriented technologies RD&T actions should anticipate, in the medium and long-term, the necessary evolutions in order to maintain the capacity of established European programmes (Galileo, Copernicus) and prepare for new ones (e.g. GOVSATCOM, SST). In addition, actions related to technologies and standardisation enabling competitiveness of the EU space industry, and allowing adaptations to new challenges in Earth observation and satellite communication missions (e.g. small satellites, constellations, new manufacturing processes) need to be supported.

This work programme relies, where applicable, on a roadmap-based approach providing European industry and research community with a long-term vision. This is implemented in conjunction with activities of Member States and ESA, for instance building on the ESA Technology Harmonisation process, to ensure greater complementarity. Examples of multi-annual research agendas implementing common roadmaps are the two established **Strategic Research Clusters** on Space Robotics and Electric propulsion which should be supported in the programming period.

Space science and exploration serve as a breeding ground for new innovative ideas and is instrumental in order for Europe to remain competitive in the sector. Thus, there is dedicated support to exploitation of space science and exploration data and development of scientific instrumentation.

Synergies with other parts of the Work Programme shall be sought. There is scope in the areas of Key Enabling Technologies or Future Emerging Technologies to consider potential application to Space, therefore improving cross-Horizon 2020 coherency.

Opportunities, on a regular basis, for **In Orbit Demonstration / Validation (IOD/IOV)** of technologies or products would enable the ultimate required qualification before using them on a real mission. The work programme should aim at setting up a regular cost-effective IOD/IOV service offering flight tickets. Such service should rely on a European approach including access to space aspects and building on complementarity with other European initiatives.

The rapidly evolving international geo-political environment and the continuing globalisation necessitate measures to defend and enhance Europe's competitiveness in Space technology and science and its autonomous access to critical technologies. There is need to deliver on

generic and mission-oriented space technologies and critical non-dependence issues including access to space and in-orbit demonstration/validation as well as support to space science.

Proposals are invited against the following topic(s):

SPACE-10-TEC-2018-2020: Technologies for European non-dependence and competitiveness

Specific Challenge: The space sector is a strategic asset contributing to the independence, security and prosperity of Europe and its role in the world. Europe needs non-dependent access to critical space technologies, which is a *sine qua non* condition for achieving Europe's strategic objectives. "Non-dependence" refers to the possibility for Europe to have free, unrestricted access to any required space technology. Reaching non-dependence in certain technologies will open new markets to our industries and will increase the overall competitiveness of the European Space sector.

Research in technologies for European non-dependence and competitiveness has been undertaken within the frame of the Commission-ESA-EDA Joint Task Force (JTF) on Critical Technologies for European non-Dependence, launched in 2008.

In 2016, the JTF established the List of Actions for 2018-2020 (hereinafter JTF List of Actions 2018-2020), aiming at enhancing the TRL of the technologies identified in the list.

Scope: Actions from the JTF List of Actions 2018-2020 shall be implemented sequentially in 2018 and in 2019 as the following subtopics.

Group A (2018):

- JTF-2018/20-3 – High Capacity FPGAs [U12]
- JTF-2018/20-8 – ASICS: 28nm Deep Sub-Micron (DSM) [U22b]
- JTF-2018/20-16 – Active discrete power components [U14]
- JTF-2018/20-18 – RF components [N27]
- JTF-2018/20-19 – Passive components [U13]
- JTF-2018/20-22 – High temperature packaging [N49]

Group B (2019):

- JTF-2018/20-2 – ASICS for mixed signal processing [U11]
- JTF-2018/20-11 – Design and qualification of μ controller for space applications [N52]
- JTF-2018/20-12 – Design and prototype of nvRAM for SPACE with serial interface ((quad)-SPI) [N53]

- JTF-2018/20-21 – High density (1000 pins and beyond) assembly capabilities and PCBs [U17]
- JTF-2018/20-28 – Photonics components [U15]
- JTF-2018/20-31 – Advanced laser crystals for high power space applications [N63]

Group C (2020):

- JTF-2018/20-5 – Very high performance microprocessors [U20]
- JTF-2018/20-9 – Design and prototype of ultra-reprogrammable SoCs [N50]
- JTF-2018/20-14 – Fiber optic or photonic integrated technology gyro-based inertial measurement unit (IMU) [U6]
- JTF-2018/20-16 – Active discrete power components [U14]
- JTF-2018/20-17 – Power amplification: travelling wave tube materials [U7]
- JTF-2018/20-23 – SW tool: automatic generation of code [N64]
- JTF-2018/20-33 – Advanced materials and material technology for combustion chambers [U4]

Context information and high-level requirements, including description of scope, initial and target TRLs, and, where applicable, references and information of related activities, are provided in the JTF List of Actions 2018-2020. Accordingly, a technical guidance document, based on the JTF List of Actions 2018-2020, is published on the Funding & Tenders Portal outlining all relevant information to the selected actions.

Activities shall be complementary and create synergy with other European activities in the same domain either in the space or non-space fields. Technological spin in and/or bilateral collaborations should be enhanced between European non-space and space industries, including technology research institutes and academia.

To this end, proposals shall include the following tasks:

- Analysis of relevant available roadmaps, including roadmaps developed in the context of actions for Key Enabling Technologies supported by the Union;
- Analysis of how their selected critical space technologies can contribute to different space applications or, where applicable, to non-space sectors (such as through technology transfer or spin off);
- Commercial assessment of the supply chain technology in the space or non-space domains and, if applicable, a business plan for commercialisation with a full range (preload) of recurring products

With a view to achieving the non-dependence objective, applicants must

- Describe the technologies and/or technology processes to be used and show that they are free of any legal export restrictions or limitations, such as those established in the International Traffic in Arms Regulations (ITAR) or equivalent instruments applicable in other jurisdictions;
- Set up a suitable technology development process aiming at avoiding export restrictions of non-EU states.

The involvement of post-graduate scientists, engineers and researchers and the promotion of gender balance is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Proposals under this topic may be subject to security scrutiny if they could potentially lead to security-sensitive results that should be classified (see guide for classification available at the Funding & Tenders Portal).

Expected Impact:

- To reduce the dependence on critical technologies and capabilities from outside Europe for future space applications, as identified in the JTF List of Actions 2018-2020;
- To develop or regain in the mid-term the European capacity to operate independently in space, e.g. by developing in a timely manner reliable and affordable space technologies that in some cases may already exist outside Europe or in European terrestrial applications;
- To enhance the technical capabilities and overall competitiveness of European space industry vendors on the worldwide market;
- To open new competition opportunities for European manufacturers by reducing dependency on export restricted technologies that are of strategic importance to future European space efforts;
- To improve the overall European space technology landscape and complement and/or create synergy with activities of European and national either in the space or non-space fields.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-11-TEC-2018: Generic space technologies

Specific Challenge: In the mid- and long-term the competitiveness of the space sector and its ability to serve the Union's internal and external policies, including the Space Strategy for Europe and the Common Security and Defence Policy, depends on the continuous incorporation of advanced basic technologies of common interest to all applications, including cross-cutting technologies such as power management, thermal control, materials and structures.

Advancements in these technology domains are necessary to enable new spacecraft or mission concepts with higher performances, higher power demand, lower mass and cost, such as higher data throughput systems and mega-constellations. As well, they can contribute to mitigate the risks related to the European dependence in space technologies. Moreover, a number of related challenges have parallels to terrestrial challenges, for example in the fields of aeronautics, energy, environment, advanced materials and production methods. Complementarity and synergy with on-going or planned European developments both in the space and non-space sectors is a challenge to address.

Scope: Activities shall advance, or spin-in from other fields, space technologies in the domain of power management, thermal control, materials, structures and processes. Incremental or potentially disruptive advancements can be both targeted.

Proposals based on low TRL technologies are solicited. The target is to demonstrate these up to medium TRL (4-6).

Each proposal shall address only one of the following sub-topics:

a) Innovative solutions for very high power systems, including solutions for power generation, storage, control and distribution able to support highly dissipative missions requirements. Innovation is sought in the areas of the high power electrical propulsion (> 20 kW) consistent with activities under the "In-space electrical propulsion and station keeping" SRC, very high throughput satellites, high power active antennas in high frequency bands, high capacity battery cells, low-cost ultra-capacitors, technologies for flexible/foldable arrays (aiming at >25 kW, addressing mechanical architecture and flexible solutions), regenerative fuels cells, low cost direct drive units, solar cells;

b) Innovative thermal control solutions for high temperature missions: high power communications, high voltage and high power systems, pose growing challenges to the thermal budget of the spacecraft or re-entry vehicle. Innovation is sought in the area of materials and thermal control solutions (e.g. heat pumps, advanced loop heat pipes, mechanical pumped loops, flexible self-regulated heaters), addressing thermal protection, thermal regulation, thermal stability, materials with variable emissivity/absorptivity; innovative thermal control surfaces, conductive/dissipative carbon fibre reinforced plastic (CFRP) panel;

c) Spacecraft bus stability and line-of-sight technologies: critical sensors and actuator solutions for high stability and line-of-sight control at spacecraft platform level, including

sensors and actuators, focusing on competitiveness through efficiency and miniaturisation (and hybridisation);

d) Advanced materials, structures and production techniques (e.g. additive manufacturing): activities shall address technologies applied to space flight elements manufacturing with a focus on low-cost on-ground manufacturing processes in support to mega-constellations or on on-orbit manufacturing processes in support to space exploration;

e) Ground systems with massive processing: data processing capabilities of missions for different applications, including ground control stations for remote sensing operations; processing power and speed, post-processing, data fusion, data networks, configuration life-cycle management and operations (particularly for constellations, including mega-constellations), integration of new technologies in ground systems and data processing (big data archiving and retrieval, smart data optimisation, automated data processing, distributed data platforms, artificial intelligence, full automation), distributed data exploitation platform.

Low cost solutions based on components off the shelf (COTS) are encouraged.

Participation of industry, in particular SMEs, is encouraged too.

Activities shall be complementary and create synergy with other European activities in the same domain either in the space or non-space fields. Technological spin in and/or bilateral collaborations should be enhanced between European non-space and space industries.

To this end, proposals shall include the following tasks:

- Analysis of relevant available roadmaps, including roadmaps developed in the context of actions for the development of Key Enabling Technologies supported by the Union;
- Analysis of how their selected space technologies can contribute to different space applications or, where applicable, to non-space sectors (such as through technology transfer or spin off);
- Commercial assessment of the supply chain technology in the space or non-space domains and, if applicable, a business plan for commercialisation with a full range (preload) of recurring products.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Development or spinning-in of new enabling technologies to space systems;
- Lead to radical improvements in performance, enabling emerging missions, as for instance high data throughput satellites or constellations.

- Lead to drastic improvements in efficiency, versatility, functionality and autonomy.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-13-TEC-2019: SRC – In-Space electrical propulsion and station keeping

Specific Challenge: The challenge of this strategic research cluster (SRC) is to enable major advances in Electric Propulsion (EP) for in-space operations and transportation, in order to contribute to guarantee the leadership through competitiveness and non-dependence of European capabilities in electric propulsion at world level within the 2020-2030 timeframe, always in coherence with the existing and planned developments at national, commercial and ESA level. The specific challenge of this action is to enable faster maturation of promising disruptive thruster concepts and technologies, as a necessary step towards demonstration actions. The detailed challenges are elaborated in the guidelines document 'EPIC Roadmap'¹⁵

Scope: A *disruptive electric propulsion technology* is a technology that disrupts a status quo in the space sector. It could replace the dominant technology by providing radical improvements in performance or costs which are perceived as valuable by a customer or part of the market, or it opens up new opportunities not possible with the incumbent technology. Emerging technologies that are potentially 'disruptive' often underperform compared to the dominant technology in early development phases – the underlying physics may not be fully understood for example and more R&D is required to properly ascertain performance attributes. Examples can be: disruptive improvement of performances, enabling of new operational scenarios, reducing costs of the full system etc.

Proposals shall cover one of the following two subtopics:

- **Thruster concepts or technologies** for disruptive electric propulsion systems such as Helicon Plasma Thrusters (HPT), Electron Cyclotron Resonance plasma thrusters (ECR), Magneto Plasma Dynamic thrusters (MPD), Pulsed Plasma Thrusters (PPT), micro-propulsion electric thrusters, or any other innovative electric thruster concepts and relevant technologies for disruptive electric propulsion systems.
- **Transversal concepts and technologies** for disruptive electric propulsion systems, such as power condition electronics, direct drive, magnetic nozzles, alternative propellants, testing techniques, materials.

Proposals may target any part of the technology readiness levels (TRL) scale, in particular:

- Breakthrough technologies starting at low or very low TRL (<4), aiming to promote promising and potentially disruptive thrusters concepts in the field of Electric

¹⁵ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

Propulsion. This should allow increasing of the current TRL, which in the long term could change the Electric Propulsion landscape.

- Promising technologies starting at higher TRL (≥ 4) in the field of Electric Propulsion, enabling significant improvements of Electric Propulsion system performances, cost and fit to the market. The objective here is to allow to efficiently and effectively increase the TRL. Proposal for higher TRL should include the best possible combination of a market analysis and an application impact analysis.

Proposals shall include a market analysis detailing the targeted applications and the specific key advantages of the proposed technology. Every disruptive effect shall be specifically correlated with its final application

Proposals shall not be based on technology lines mentioned in the call topic COMPET-3-2016-a for incremental EP technologies¹⁶.

The involvement of post-graduate scientists, engineers and researchers is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals for the disruptive technologies requesting a contribution from the EU of EUR 1 million for activities starting from $TRL < 4$ and of EUR 1 to 2 million for activities starting from $TRL \geq 4$ would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- To promote and accelerate the development of potentially breakthrough EP or EP-related concepts and technologies in order to be able to provoke a disruption in the propulsion landscape in the medium to long-term.
- To foster the necessary long term evolutions needed to provide Europe with competitive and innovative electric propulsion products in order to maintain the European capacity to compete in the worldwide arena of electric propulsion satellites.
- To enable the identification and targeting of future markets and applications which are not yet addressed by the current well-established products or their expected improvements.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

¹⁶ Hall Effect Thrusters (HET); Gridded Ion Engines (GIE); High Efficiency Multistage Plasma Thrusters (HEMPT)

LC-SPACE-14-TEC-2018-2019: Earth observation technologies

Specific Challenge: The challenge is to mature application-oriented technologies in the domains of Earth Observation (EO) which are expected to underpin competitiveness and contribute to the integration of space in society and economy.

The overarching objective is to improve the performance of EO systems, building on previous activities supported by the Union, Member States and ESA.

Activities in EO will focus on improving timeliness and reactivity of observations, their resolution and swath, the performance of sensors and the underlying technologies, while addressing the new challenges associated to larger data collection in remote sensing missions, including at ground segment level (e.g. massive data processing, machine learning, knowledge-based systems).

Moreover, some technologies and building blocks such as deployable antennas and/or (electrically) steerable antennas and mechanisms/structures, high mechanical/thermal stability aperture solutions, high efficiency power components, data processing and networks, or data links can provide synergies with SATCOM application domains.

Scope: The aim of this topic is to demonstrate, in a relevant environment, technologies, systems and sub-systems for Earth observation from satellites as well as from high altitude platforms. Proposals should demonstrate significant improvements in such areas as miniaturisation, power reduction, efficiency, versatility, and/or increased functionality, and should demonstrate to the viable extent complementarity to activities already funded by Member States and the European Space Agency. Proposals should also ensure system readiness for operational services and provide leverage on industry competitiveness, particularly on export markets.

Each proposal shall address only one of the following subtopics:

a) Very high resolution optical EO for LEO and/or high resolution optical EO for GEO/HEO instrument technologies, with focus on improving payload (e.g. radiometric and spectral parameters, spatial resolution, swath), including detectors, materials and solutions for stable and large optomechanical elements and systems (e.g. lightweight telescope mirrors with metre-level diameter) focal planes, wave front error and line of sight control, high performance actuators, multispectral filters for large focal plane;.

b) Competitive remote sensing instruments and space systems: innovations supporting readiness advancements for next generation systems in the optical and radio frequency domains (active/passive), technologies enabling advanced system solutions (including small satellites possibly in convoy with existing space assets), on-board image processing and detectors for video imaging with increased swath and resolution, technologies for super- and hyperspectral imaging instruments with high performance, radio occultation sensors, low cost high resolution telescopes and radar imaging systems;

c) Disruptive technologies for remote sensing, as technology building blocks for innovative LiDAR (Light Detection And Ranging) and radar instruments (including cost-effective wide-swath altimetry and imaging systems), super-spectral and hyperspectral payloads with wide spectral and/or coverage, limb sounders and gravimetry payloads; high quantum efficiency photo detectors and high-precision optical beam scanning and pointing; advanced infrared (IR) technologies (optical filters, detectors and electronics);

d) On-board data processing: integrated multi-instrument on-board payload data processing for resource-constrained missions; solutions for high observation reactivity and real-time applications such as very high performance payload processing; on board data/image optimisation and compression for advanced video and image pre-processing as well as smart on-board data/image analysis; data flow optimisation for new missions, including impacts on the evolution of associated ground segment, for enhancement of overall processing power and speed over the full chain and for supporting massive data processing and machine learning in EO applications;

e) Advanced SAR/Radar technologies: step up maturity in new sensing concepts and technologies such as large and active antennas and reflectors, including multi-frequency concepts; enablers for digital beam-forming and beam-hopping interferometric systems, and for other concepts, such as large swath maritime surveillance radar, active sensing/processing of SAR ships, data fusion integration with new generation Automatic Identification Systems (AIS);

Low cost solutions based on components off the shelf (COTS) are encouraged.

Participation of industry, in particular SMEs, is encouraged.

Activities shall be complementary and create synergy with other European activities in the same domain.

To this end, proposals shall include the following tasks:

- Analysis of relevant roadmaps, including roadmaps developed in the context of actions for the development of Key Enabling Technologies supported by the Union, and where available, roadmaps developed by the European Space Agency and European national space programmes;
- Commercial assessment of the supply chain technology in the space or non-space domains and, if applicable, a business plan for commercialisation with a full range (preload) of recurring products.

The involvement of post-graduate scientists, engineers and researchers is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately.

Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Improvement in the capability, including through miniaturisation and power reduction, precision, efficiency or other characteristics with respect to existing Earth observation missions, opening new avenues for future space systems;
- Substantial improvement in state-of-the-art technologies in key areas such as optical and radar systems, radio occultation sensors, sounders, LiDARs for Earth observation, and related key technologies, as for instance detectors and antennas;
- Enabling synergic use of heterogeneous Earth Observation constellations;
- Strengthening Europe's position in industrial competitiveness in technologies for Earth observation payloads and missions;
- Greater industrial relevance of research actions and output as demonstrated by deeper involvement of industry, including SMEs, and stronger take-up of research results.
- Fostering links between academia and industry, accelerating and broadening technology transfer.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-15-TEC-2018: Satellite communication technologies

Specific Challenge: The context and customer field of satellite communication services is currently undergoing changes. Broadband TV applications are decreasing in importance and the importance of internet connectivity is increasing. New EU targets have been set to achieve a connectivity of 100 Mbps for all by 2025¹⁷, for which satellite communication solutions are important, for instance in remote and offshore areas, for backhauling, or for mobile users and under emergency situations. The demand for Very High Throughput satellite communications is increasing. The 5G concept combines various access technologies, such as cellular, wireless, satellite and wireline, for delivering reliable performance for critical communications and improve area coverage^{18 19} making interconnectivity an important challenge. New markets are emerging, such as for example the connectivity needed for Internet of Things. New mission concepts are currently being established, such as mega constellations or satellite networks based on micro-mini satellites. Finally, security aspects are

¹⁷ Commission Communication on: Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society - COM(2016)587 and Staff Working Document - SWD(2016)300

¹⁸ <https://ec.europa.eu/digital-single-market/en/news/communication-5g-europe-action-plan-and-accompanying-staff-working-document>

¹⁹ <https://5g-ppp.eu/wp-content/uploads/2017/03/5GPPP-brochure-final-web-MWC.pdf>

becoming more and more important, in particular for governmental users of satellite communications. The challenge for the EU is to prepare the ground to maintain the technological leading edge and maintain its global competitiveness in satellite communications in those rapidly changing conditions and markets (e.g. towards and beyond the 1 Tbps high throughput satellites and/or fully flexible satellites)

Scope: Proposals shall address one of the following sub-topics:

a) Secure and robust satellite communications, such as key generation and distribution, adapting to quantum technologies, anti-jamming technologies and products, anti-spoofing techniques, advanced coding, signal modulation and cryptography, secured uncoordinated multiple access, threats simulation, secure and robust telemetry, tracking and command (spread spectrum);

b) Bandwidth efficient transmission techniques to serve multiple users with high throughput satellites, e.g. frequency reuse techniques, multiple antenna communications, beamforming, cooperative gateway diversity, user clustering and interference mitigation;

c) High speed processing and flexible and reprogrammable telecommunication payloads, able to adapt to changing service needs such as capacity flexibility and geographic redistribution of the traffic and to satellites integration in the 5G protocol and system. Simulation and end-to-end resources management shall be addressed;

d) Optical communications, including photonics, for very high throughput systems with more than 10 Gbps (e.g. hybrid RF/optical payloads use of optical up- and down links), on-board and ground aspects focusing on feeder links, system and architecture aspects encompassing technologies such as enhanced space-to-ground/RPAS; low complexity on-board processing and limited coherent processing; orbit to ground mission data download focussing on very high throughput optical feeder links (up to 1 Tbps) and very high speed rates optical ground station for feeder links (towards 1Tbps);

e) Flexible broadband passive and active antenna techniques, such as phased array antennas for very high throughput spaceborne or airborne satellite communication applications (consisting of broadband conformal antenna arrays, broadband beamforming and broadband RF front-ends), including multi-beaming smart antennas and integration of antennas in the platform, active antenna critical technologies, lens antenna techniques, 5G dedicated active arrays;

f) Inter-satellite links, data relay solutions and on-board switching, for potential future LEO constellations (including constellations of small satellites), supporting high data rates relay (up to 40 Gbps), including terminals, in such diverse contexts as GEO/MEO to LEO, airborne (including RPAS) to GEO;

g) Advanced RF equipment in terms of higher frequency bands (e.g. Q, V/W) and re-configurability (e.g. GaN HPAs, optimised TWTA, LNAs);

h) Ground systems technologies for satellite communication services and applications: evolution of ground control stations and teleports, also enabling full interoperability with future terrestrial telecommunication networks (including 5G) and optimising performance, coverage, costs, reliability and security in the provision of differentiated services and applications to diverse user categories.

Proposals shall consider enabling technologies and solutions aiming at exploiting the potential synergies between the Satellite Communication domain and the Navigation and Earth Observation domain (such as EO/SatCom hybrid mission satellites, smart satellites, high data rate solutions, high speed links, high performance processors, antennas/reflector/structures, ground segment).

Participation of industry, in particular SMEs, is encouraged.

Activities shall be complementary and create synergy with other European activities in the same domain. Emphasis shall be given to the preparation of future and advanced satellite communications technologies up to TRL 4-5. Technological spin in and/or bilateral collaborations should be enhanced between European non-space and space industries.

To this end, proposals shall include the following tasks:

- Analysis of relevant available roadmaps, including roadmaps developed in the context of actions for the development of Key Enabling Technologies supported by the Union;
- Commercial assessment of the supply chain technology in the space or non-space domains and, if applicable, a business plan for commercialisation with a full range (preload) of recurring products.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- To ensure and enhance the life-cycle cost reduction (including manufacturing and operations) and increased performance, resulting in the enhanced competitiveness of the European space manufacturing and service industry in the rapidly evolving field of satellite communication.
- To develop European research and technology ecosystems consisting of different parties involved in satellite communications, i.e. manufacturers of user equipment, ground segment technologies, service providers and operators, validation and simulation tool developers, and end users.
- To contribute to the integration of satellite communication into the 5G.

- Greater industrial relevance of research actions and output as demonstrated by deeper involvement of industry, including SMEs, and stronger take-up of research results.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-16-TEC-2018: Access to space

Specific Challenge: Access to space is an indispensable element of the entire value chain of space and has been recognised as an area of strategic importance towards the direction of Europe's non-dependence.

Access to space is a matter of security of supply, industry capability and technology readiness and a *sine qua non* condition of the modern space knowledge-based economies. Only a handful of space-faring countries master this capability as a result of extensive institutional funding for research and development costs and the guarantee of services exploitation. Europe has achieved its remarkable position in this field thanks to national programmes and the programmes of the European Space Agency, Access to Space being one fundamental origin of its creation in 1975.

The Space Strategy for Europe has confirmed that Europe shall maintain autonomous, reliable and cost-effective access to space. It underlined that it is crucial that Europe continues to have modern, efficient and flexible launch, production and test infrastructure facilities.

Cost reduction and improving flexibility of European launch systems are the main challenges in order to foster European industry competitiveness on the global market.

The industry 4.0 transformational wave is likely to bring opportunities for lowering the cost of space launch manufacturing/integration/testing/operations and further improving quality.

The specific challenge is to support research and innovation in technologies, in complementarity and full synergy with the on-going work undertaken by Member States and European initiatives, contributing to:

- Investigate the potential Launch system reusability technologies;
- Launch system advanced manufacturing and modern ground infrastructures.

Scope: Each proposal shall address only one of the following two sub-topics:

a) Potential Launch system reusability technologies and their applicability for European needs: With an aim at further lowering cost for the next generation of European launchers and transportation systems, activities shall only address new technologies relevant to reusability, such as advanced avionics and data management (e.g. optimised return concepts including autonomous safety), advanced structural parts and materials, health monitoring systems and non-destructive control technologies, advanced propulsion systems & equipment (e.g.

propellant management, disconnection systems and special ground systems). These could be used as building blocks for in-flight demonstration. The activities shall include an assessment of the cost effectiveness of the proposed new technologies expected for the exploitation phase (flight and ground operations) and an estimation of the necessary investments and time schedule needed to reach TRL 8/9.

TRL 5/6 should be sought at completion of the proposed activities in view of a possible IOD/IOV in-flight demonstration as a next step.

b) Launch system advanced manufacturing (e.g. tooling and machines) and modern infrastructures (including ground infrastructures for low cost European launch sites):

Activities shall address technologies and processes applied to launch systems development, production, testing and operations (applicable to European space transportation systems including mini and micro launch systems) such as automation of activities (e.g. automated guided handling tools, automated integration, and inspection, collaborative robots, automated testing), digital technologies to the benefit of quality and costs (e.g. usage of COTS (commercial-of-the-shelf) equipment, digital assistance to operators, big data processing for continuous improvement), advanced materials with accent on low-cost manufacturing processes (e.g. 3D printing, composite, joining technology) and remote operations (e.g. remote control centre, improved safety management), ground infrastructures for European launch sites including for low cost access to space for mini, micro, nano satellites, including commercial initiatives. The proposed solutions to be considered will take into account the possible evolutions of the regulatory framework, in particular REACH, and will also take into account the environmental impacts and health risks.

For each topic, activities shall be complementary with other European activities in the same domain.

These activities shall consist of research, innovation, development and qualification work which can be readily integrated within current and planned European launch, test and production infrastructures. A preliminary implementation plan shall be included in the proposal and detailed during the action.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Improved European competitiveness in cost-effective reusability technologies for space transportation systems complementary with other European activities in the same domain leading to launch system reusability solutions which could be demonstrated in flight within three to five years, including forecast of investment needed;
- Increase compliance with the evolutions of the regulatory framework, in particular REACH;

- Improved quality and safety control solutions, which are absolutely fundamental in rocketry;
- Cost reduction of space transportation system manufacturing, integration, testing and operations thanks to research and innovation in advanced manufacturing and modernisation of infrastructures taking into account the evolution of the normative framework and environmental impacts. This is aimed at improving the overall competitiveness of European solutions on the worldwide market and helping create new jobs;
- Integration of human factors in ground facilities, such as improved work environment for operators, efficiency, quality of operations and human safety.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-17-TEC-2019: Access to space

Specific Challenge: Access to space is an indispensable element of the entire value chain of space and has been recognised as an area of strategic importance towards the direction of Europe's non-dependence.

Access to space is a matter of security of supply, industry capability and technology readiness and a *sine qua non* condition of the modern space knowledge-based economies. Only a handful of space-faring countries master this capability as a result of extensive institutional funding for research and development costs and the guarantee of services exploitation. Europe has achieved its remarkable position in this field thanks to national programmes and the programmes of the European Space Agency ESA, Access to Space being one fundamental origin of its own creation in 1975.

The Space Strategy for Europe has confirmed that Europe shall maintain autonomous, reliable and cost-effective access to space. It underlined that it is crucial that Europe continues to have modern, efficient and flexible launch, production and test infrastructure facilities.

Cost reduction and improving flexibility of launch systems are the main challenges in order to foster European industry competitiveness on the global market.

The industry 4.0 transformational wave is likely to bring opportunities for innovative concepts lowering the cost of space launch manufacturing/integration/testing/operations and further improving quality.

Scope: Each proposal shall address only one of the following two sub-topics:

a) Innovative concepts for low cost launch system and services for mini-, micro-, nano-satellites and cubesats: with an aim at further increasing launch frequency and lowering launch costs including for those satellites with dedicated orbit requirements (e.g. precise

orbital insertion for nano-cubesat satellites), for the worldwide commercial market,. They shall seek coherence and complementarity with on-going ESA initiatives. Proposals could include for instance, upper stage related technologies (e.g. disruptive technologies for upper stage low thrust / high Specific Impulse / green propellant engine, avionic miniaturisation, dispensers with advanced deployment capabilities) and the identification of advanced low cost materials.

b) Launch system advanced manufacturing (e.g. tooling and machines) and modern infrastructures (including ground infrastructures for low cost European launch sites for mini, micro nano satellite launch system): Activities shall address manufacturing technologies and processes such as integrated supply chain, integrated European manufacturing flow (global use of digital mock-up within extended enterprise), digitalisation standardisation applied to space (space related data exchange, harmonisation of process, cloud centric exchange of data), remote control capacities useful to all European actors (satellites industrialists, launch pads, rocket propulsion test centres and launcher industrialists) and competences capitalization in support of digital training (shared space curricula supported by numeric know-how capture) as well as advanced assembly, integration and testing, including small, mini, micro satellite launch systems.

The proposed solutions to be considered will take into account relevant regulatory frameworks, in particular REACH, and will also take into account the environmental impacts and health risks.

These activities shall consist of research, innovation and development work which can be readily integrated within current and planned European launch infrastructures. A preliminary implementation, operational and total investment plan shall be included in the proposal and detailed during the action.

For each topic, activities shall be complementary with other European activities in the same domain.

Proposals shall include an analysis of relevant available roadmaps at European level.

The involvement of post-graduate scientists, engineers and researchers is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Contribution to the maturing of technologies to Launch Systems/services for small satellites in dedicated orbits and with a strong focus on cost reduction and launch rate flexibility;

- Innovative use of current Launcher technologies for mini-, micro-launchers, and associated ground segment solutions that will contribute to pursue and facilitate, in the short-term, extreme low-cost launch services for the worldwide market of small satellites and constellations, thus enabling also private initiatives to build viable business cases based on such technologies;
- Improve business performance of European space start-ups/scale-ups (e.g. via precise deployment of their space asset and reduction of time required to have the constellation fully operational).
- Increase compliance with the evolutions of the normative regulatory framework, in particular REACH;
- Improved quality and safety control solutions, which are absolutely fundamental in rocketry, within three to five years;
- Supply chain efficiency applied to space launch manufacturing, integration and operations thanks to research and innovation data exchange architecture taking into account the evolution of the normative framework and environmental impacts.
- Improved workforce competence management and European top-class space curricula.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-20-SCI-2018: Scientific instrumentation and technologies enabling space science and exploration

Specific Challenge: Great advances in the knowledge of the Universe and the Solar system have been enabled by the data delivered by space science as well as human and robotic exploration missions and ground-based space observatories. Europe contributed to these endeavours by developing and implementing world-class space missions and ground-based infrastructure, in the context of national, ESA and ESO scientific programmes, and often in partnership with major international players.

Continued collaborative efforts are needed to prepare the scientific instruments and technologies that will enable future space science and exploration missions.

The challenge is to foster cooperation between scientific, engineering and industrial teams, within and outside Europe, to develop instrumentation and technologies enabling space science and exploration, including planetary exploration, missions, stimulating synergies between space and ground-based observations combining and reusing different technologies, techniques and methodologies.

Scope: The development of instrumentation and technologies enabling space science and exploration missions may address early scientific instrumentation and technology

development associated to future space science and exploration, including planetary exploration missions. The development of new and innovative approaches, such as the use of Cubesats and other small space platforms, including planetary entry probe, or the use of Commercial off-the-shelf (COTS) components is encouraged as long as it leads or contributes to the implementation of space science and exploration with significant scientific outputs.

Advances are expected in support to on-site activities such as landing, planetary navigation, sample collection and processing or in-situ analysis.

Activities should target primarily European and European-led space science and exploration missions or internationally-led missions where the participation of European partners provides demonstrated added-value in terms of technological development and scientific output.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Increased collaboration of scientific, engineering and industrial teams both within and outside Europe across different domains;
- Enable breakthroughs in terms of the capacity to exploit scientific space data and in terms of developing scientific instrumentation and technologies used in space science and exploration missions.
- Validation of novel human spaceflight and robotic space instrumentation and technologies through analogue tests.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-28-TEC-2020: SRC - In-space electrical propulsion and station keeping - Incremental technologies

Specific Challenge: The challenge of this strategic research cluster (SRC) is to enable major advances in Electric Propulsion (EP) for in-space operations and transportation, in order to contribute to the European leadership through competitiveness and non-dependence in electric propulsion at world level within the 2020-2030 timeframe, always in coherence and non-duplication with the existing and planned developments at national, commercial, EU and ESA level.

Scope: Incremental Technologies are those currently considered mature enough to allow incremental steps enabling new capabilities required by a number of applications.

Proposals should, therefore, enable incremental advances in the already mature technologies for Electric Propulsion Systems²⁰ based on:

1. Hall Effect Thrusters (HET)
2. Gridded Ion Engines (GIE)
3. High Efficiency Multistage Plasma Thrusters (HEMPT).

The advantage of having several mature technologies in the portfolio is a particular strength of the European EP scene. The three Incremental Technologies have individual strengths and weaknesses, which make them more competitive for certain applications and less competitive for others.

The EPIC roadmap developed by the EPIC PSA addresses all three technologies in the Incremental Technology line. The COMPET-3-2016-a Call allowed the three Electric Propulsion Systems based on these technologies, to be developed to higher TRL levels on a first stage (2016-2020), while complying with certain requirements and TRL objectives to address the needs of a number of applications.

Regarding new markets and applications, as constellations in the Low power range, and dual mode features for Electric Orbit Raising (EOR) and Station Keeping (SK) in the Medium power range, it is not possible to tell at the time being, which Incremental Technology would be the best suited for the market at the end of the SRC (2023/2024). This approach guarantees a high flexibility to react to possible changes of the satellite market needs and unforeseen developments of the launcher market, giving to the European stakeholders a strategic and flexible position, clearly demanded by Satellite Operators and Large System Integrators.

Proposals shall address further development of the most promising Incremental Technologies which have a TRL not lower than the expected target from the COMPET-3-2016-a Call, up to design, industrialisation and qualification level of the overall Electric Propulsion System, in order to guarantee the current leadership through competitiveness of European electric propulsion.

Actions should focus on design, industrialisation and qualification to allow flight readiness of the overall Electric Propulsion System in the required SRC timeframe, by means of an advanced Engineering Model (EM) built on the results obtained from the bread board model developed in the COMPET-3-2016-a Call, to be followed by a Qualification Model (QM). Proposals should seek to cover incremental developments up to the specified TRL level.

Proposals should enable incremental advances on the already mature technologies for Electric Propulsion Systems, with the focus on product development for the most promising applications and future expected markets in line with the market studies: Telecom

²⁰ Electric Propulsion System components are: thruster, fluid management system and the power components only. The mechanisms, deployment and tanks are excluded, as indicated in the EPIC Roadmap and guidelines (available on the Funding & Tenders Portal).

applications, Constellation, Navigation, LEO applications, Exploration and Space transportation.

The retained application domains are identified for the call into 3 power range classes: Low power (i.e. for constellations and LEO applications) from 200 W to 700 W; Medium power dual mode i.e. for Telecom and Navigation applications > 3.0 kW for SK and > 5.0 kW for EOR, and High power (i.e. for Exploration and Space transportation) > 20.0 kW.

Proposals should provide for each product the attainable objectives at the end of the phase 2 in terms of performance (thrust, specific impulse (ISP), power), of costs (recurring costs) and achieved TRL. A detailed description of the above Incremental Technologies and the most promising applications is included in the corresponding guidelines available on the Funding & Tenders Portal.

Proposals on Incremental Technologies should demonstrate the readiness and interest to carry the developments further on for a possible future in-orbit demonstration (IOD) and a business plan on how to access the current or future expected markets.

The Commission considers that proposals for the Incremental Technologies requesting contributions in the following amounts would allow this specific challenge to be addressed appropriately.

Proposals are invited for the following three sub-topics:

a) Low power electric propulsion

- A total of EUR 12 million will be granted to **Low power Electric Propulsion Systems** (i.e. for Constellations and LEO applications) from 200 W to 700 W. The maximum requested EU funding per proposal is EUR 4 million. The target TRL at the end of the project should be at least [6/7].
 - o At least one proposal will be selected for line 1/HET.
 - o At least one proposal will be selected for line 2/GIE.
 - o At least one proposal will be selected for line 3/HEMPT.

b) Medium power electric propulsion

- A total of EUR 9 million will be granted to **Medium power dual mode** (i.e. for Telecom and Navigation applications) > 3.0 kW for SK and > 5.0 kW for EOR. The maximum requested EU funding per proposal is EUR 4.5 million. The target TRL at the end of the project should be at least [6/7].
 - o At least two proposals will be selected, each one of a different technology from the three Incremental Technologies (HET, GIE, HEMPT).

c) High power electric propulsion

- A total of EUR 3 million will be granted to a **High power** (i.e. for Exploration and Space transportation) > 20.0 kW. The maximum requested EU funding per proposal is EUR 3 million. The target TRL at the end of the project is [5/6].
 - o At least one proposal will be selected from the three Incremental Technologies (HET, GIE, HEMPT).

Grants awarded under this topic will be complementary to each other and complementary to grants awarded under other previous SRC Calls topics: COMPET-3-2016-a, COMPET-3-2016-b, SPACE-13-TEC-2019 ("complementary grants"). In order to ensure a smooth and successful implementation of this Strategic Research Cluster (SRC), the beneficiaries of complementary grants ("complementary beneficiaries") shall conclude a written "collaboration agreement".

Proposals under this topic may be subject to security scrutiny if they could potentially lead to security-sensitive results that should be classified (see guide for classification available at the Funding & Tenders Portal).

Expected Impact:

- To develop, in the mid-term, the European capacity to compete in the worldwide arena of electric propulsion satellites and missions and be in time to market.
- To substantially increase medium and long term competitiveness of existing Electric Propulsion System technologies with a technology and application-driven approach.
- To pursue developments which shall be mainly market-oriented, beneficial at system level and with a strategic view to long term needs.
- To enable medium and longer term applications: Telecom, Space Transportation, LEO, MEO, Exploration or Science.
- To anticipate ambitious long-term market evolution and strategic opportunities, so that the developed Electric Propulsion Systems could create new markets and shape existing ones.
- To develop the Incremental Technology Electric Propulsion System up to system demonstration in a space environment and ready for its qualification.

Type of Action: Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-29-TEC-2020: Satellite communication technologies

Specific Challenge: The context and customer field of satellite communication services is currently undergoing changes. Broadband TV applications are decreasing in importance and

the importance of internet connectivity is increasing. New EU targets have been set to achieve a connectivity of 100 Mbps for all by 2025²¹, for which satellite communication solutions are important, for instance in remote and offshore areas, for backhauling, or for mobile users and under emergency situations. The demand for Very High Throughput satellite communications is increasing. The 5G concept combines various access technologies, such as cellular, wireless, satellite and wireline, for delivering reliable performance for critical communications and improve area coverage^{22 23} making interconnectivity an important challenge. New markets are emerging, such as for example the connectivity needed for Internet of Things. New mission concepts are currently being established, such as mega constellations or satellite networks based on micro-mini satellites. Finally, security aspects are becoming more and more important, in particular for governmental users of satellite communications. The challenge for the EU is to prepare the ground to maintain the technological leading edge and maintain its global competitiveness in satellite communications in those rapidly changing conditions and markets (e.g. towards and beyond the 1 Tbps high throughput satellites and/or fully flexible satellites).

Sub-topics presented in the “SPACE-15-TEC-2018: Satellite communication technologies” call and addressed by selected projects, are not repeated in SPACE-29-TEC-2020.

Scope: Proposals shall address only one of the following sub-topics:

- a) Secure and robust satellite communications including quantum technologies**, such as key generation and distribution, adapting to quantum technologies, anti-jamming technologies and products, anti-spoofing techniques, advanced coding, signal modulation and cryptography, secured uncoordinated multiple access, threats simulation, secure and robust telemetry, tracking and command (spread spectrum);
- b) Bandwidth efficient transmission techniques** to serve multiple users with high throughput satellites and to ensure effective use of limited spectrum resources, e.g. frequency management and allocation techniques, such as dynamic spectrum access (DSA) and frequency reuse; multiple antenna communications; beamforming; cooperative gateway diversity, user clustering and interference mitigation;
- c) High speed processing and flexible and reprogrammable telecommunication payloads**, able to adapt to changing service needs such as capacity flexibility and geographic redistribution of the traffic and to satellites integration in the 5G protocol and system. Simulation and end-to-end resources management shall be addressed;
- d) Flexible broadband passive and active antenna techniques**, such as phased array or mechanically steered or hybrid mechanical/electronic steerable antennas for very high throughput spaceborne or airborne communication applications (consisting of broadband

²¹ Commission Communication on: Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society - COM(2016)587 and Staff Working Document - SWD(2016)300

²² <https://ec.europa.eu/digital-single-market/en/news/communication-5g-europe-action-plan-and-accompanying-staff-working-document>

²³ <https://5g-ppp.eu/wp-content/uploads/2017/03/5GPPP-brochure-final-web-MWC.pdf>

conformal antenna arrays, broadband beamforming and broadband RF front-ends and components), including multi-beaming smart antennas and integration of antennas in the platform, multiband and hybrid (RF/optical) antennas, active antenna critical technologies, lens antenna techniques, 5G dedicated active arrays, RF equipment for higher frequency bands (e.g. Q, V/W).

e) Ground systems technologies for satellite communication services and applications: evolution of ground control stations and teleports, also making use of artificial intelligence, improving the interoperability of networks of ground stations and inter-satellite links, enabling full interoperability with future terrestrial telecommunication networks (including 5G terrestrial network) and optimising performance, coverage, costs, reliability and security in the provision of differentiated services and applications to diverse user categories,.

Maximum one proposal per sub-topic will be selected.

Proposals should consider enabling technologies and solutions aiming at exploiting the potential synergies between the Satellite Communication domain and the Navigation and Earth Observation domain (such as EO/SatCom hybrid mission satellites, smart satellites, small satellites, high data rate solutions, high speed links, high performance processors, antennas/reflector/structures, ground segment).

Participation of industry, in particular SMEs, is encouraged.

The involvement of post-graduate scientists, engineers and researchers and the promotion of gender balance is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

Actions should be complementary and create synergy with other European activities in the same domain. Emphasis should be given to the preparation of future and advanced satellite communications technologies up to TRL 4-5. Technological spin in and/or bilateral collaborations should be enhanced between European non-space and space industries.

To this end, proposals shall include the following tasks:

- Analysis of relevant available roadmaps, including roadmaps developed in the context of actions for the development of Key Enabling Technologies supported by the Union;
- Commercial assessment of the supply chain technology in the space or non-space domains and, if applicable, a business plan for commercialisation with a full range (preload) of recurring products.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Proposals under this topic may be subject to security scrutiny if they could potentially lead to security-sensitive results that should be classified (see guide for classification available at the Funding & Tenders Portal).

Expected Impact:

- To ensure and enhance the life-cycle cost reduction (including manufacturing and operations) and increased performance, resulting in the enhanced competitiveness of the European space manufacturing and service industry in the rapidly evolving field of satellite communication.
- To develop European research and technology ecosystems consisting of different parties involved in satellite communications, i.e. manufacturers of user equipment, ground segment technologies, service providers and operators, validation and simulation tool developers, and end users.
- To contribute to the integration of satellite communications into the 5G.
- Greater industrial relevance of research actions and output as demonstrated by deeper involvement of industry, including SMEs, and stronger take-up of research results.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-30-SCI-2020: Scientific data exploitation

Specific Challenge: Support the data exploitation of European missions and instruments, in conjunction, when relevant, with international missions.

Scope: This topic will cover the exploitation of all acquired and available data provided by space missions in their operative, post-operative or data exploitation phase and by space-related ground based investigations.

Projects may rely on the data available through ESA Space Science Archives when possible or other means (e.g. instrumentation teams). Combination and correlation of this data with international scientific mission data, as well as with relevant data produced by ground-based infrastructures all over the world, is encouraged to further increase the scientific return and to enable new research activities using existing data sets. These activities shall add scientific value through analysis of the data, leading to scientific publications and higher level data products, tools and methods. When possible, enhanced data products should be suitable for feeding back into the ESA archives. Resulting analyses should help preparing future European and international missions.

International cooperation is encouraged in particular with countries active in space exploration and space science.

The involvement of post-graduate scientists, engineers and researchers and the promotion of gender balance is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 2 million would allow this specific challenge to be addressed appropriately, including through proposals from small teams. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: A higher number of scientific publications based on Europe's space data, high-level data products made available through appropriate archives, and tools and methods developed for the advanced processing of data. Proposals are also expected to add value to existing activities on European and international levels, and to enhance and broaden research partnerships.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Artificial Intelligence and Space

The adoption of Big Data technologies and Artificial Intelligence in the space industry represents a significant opportunity to innovate. The space environment puts extreme demands on reliability and autonomy where modern AI techniques can provide solutions for autonomous decision-making, self-diagnosis and repair for on-orbit missions and robotic exploration of other planets. The robotics cluster provides a suitable platform for applying such technologies.

Proposals are invited against the following topic(s):

SPACE-12-TEC-2018: SRC – Space robotics technologies

Specific Challenge: The overall challenge of this strategic research cluster (SRC) is to enable major advances in space robotic technologies for future on-orbit missions (robotics and proximity rendezvous) and the exploration of the surfaces of the other bodies in our solar system.

The first activities in the SRC have addressed designing, manufacturing and testing of reliable and high performance common robotic building blocks for operation in space environments (orbital and/or planetary) which will be used for the activities subject to this call. The specific challenge is now to integrate the previously prepared common building blocks into demonstrators on ground, towards applications of space robotics in the field of orbital and planetary use. These robotics applications address not only the future needs of exploration and exploitation of space but also potential spin-off and spill-over effects to other areas of robotic activity on Earth, such as automotive, mining, construction, nuclear, or underwater.

Scope: Each proposal shall address only one of the following sub-topics:

a) Orbital Support Services: demonstrate the techniques needed to offer a commercial service to operational satellites. This shall as minimum address robotic deployment and refuelling of satellites in orbit. By means of a general purpose robotic arm, a servicing satellite must be capable to demonstrate release, grasping, berthing and manipulation of a target satellite including services such as refuelling.

b) Robotised assembly of large modular orbital structures: integrate a robot system and a set of functional modules that can assemble a large structure (such as a large reflector) otherwise not feasible with a single launch.

c) Robotised reconfiguration of satellites: develop a satellite-mounted robot system and its related implements that can modify the functionality of a satellite by adding/replacing modules available on-board or provided by another servicing satellite.

d) Autonomous decision making: integrate a rover system with long traverse capabilities (kilometres a day) managing independently the decisions required to reduce risks and seize opportunities. Such a rover system will be required to travel independently from a starting point (e.g. a lander) towards an end point (say a cache of sample), perform independent opportunistic science on the way and return to the lander with the acquired soil sample.

e) Exploring robot-robot interaction. Proposals could address one of the following two scenarios. **Advanced mobility:** a suite of robots endowed with diverse mobility that can cooperate autonomously in the exploration of very hard-to-reach planetary areas. This team of robots will be entrusted to undertake multiple descents and ascents into a crater/gully performing coordinated mapping and science. **Robotised construction:** a team of specialised robots with multiple robotic arms and end-effectors that, through a minimum of drilling, excavating and manipulating, can cooperatively put together a future planetary base/ISRU ²⁴ plant.

Proposals shall build on the results of the five projects of the 2016 call developing common building blocks of the Robotics SRC and shall therefore describe how this is done. A guidance document is published together with this work programme²⁵.

The Commission considers that proposals requesting a contribution from the EU of between EUR 3 and 4 million for sub-topics a) to c) and EUR 2 and 3 million for sub-topics d) to e) would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: Space robotics technologies developed under this topic are expected to increase the performance of space missions in a cost effective manner. Synergies with terrestrial robotics would increase the sustainability of the European space sector at large.

Additionally, for the orbital track (sub-topics a, b and c):

- Enable multiple business cases not possible with current monolithic satellite systems

²⁴ ISRU = In Situ Resource Utilisation.

²⁵ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

- Foster rapid development and production on demand to reduce cost and time
- Setting technology standards for commercialisation of space (interfaces, building blocks etc.)

Additionally, for the planetary track (sub-topics d and e):

- Improve yield of planetary missions by providing 10x more science
- Allow estimation of feasibility of planetary exploitation activities
- Spin-out of space robotics technologies, e.g. *autonomy*, to terrestrial activities such as agriculture and mining.
- Spin-in of terrestrial activities (e.g. automated waste handling) to the space robotics sector.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-27-TEC-2020: SRC - Space robotics technologies

Specific Challenge: The overall challenge of this Strategic Research Cluster (SRC) is to enable major advances in space robotic technologies for future on-orbit missions requiring robotic activity and proximity rendezvous, and the exploration of the surfaces of the other bodies in our solar system.

The first activities in the SRC have addressed designing, manufacturing and testing of reliable and high performance robotic Common Building Blocks for operation in space environments (orbital and/or planetary). The specific challenge of the second call was to integrate the previously prepared Common Building Blocks into demonstrators on ground, towards applications of space robotics in the field of orbital and planetary use. These robotics applications address the future needs of exploration (advanced autonomy and robot cooperation relying on AI and other techniques) and commercial exploitation of space (on-orbit servicing, in-orbit assembly and reconfigurable satellites).

The objective of this third call is to prepare the technologies for demonstrators planned to be implemented in the 2023-2027 timeframe. The successful proposals shall validate relevant applications for both orbital and planetary scenarios relying on technologies derived from previous SRC activities.

Scope: Each proposal shall address only one of the following sub-topics:

a) In-orbit Demonstrator Mission Study: a study (up to and including Phase B1) of an In-Orbit Demonstrator (IOD) that will validate previous developments of the SRC for the purpose of simultaneously satisfying short-term (ie on-orbit inspection, life extension, de-

orbiting) and mid-to-long-term (ie APM exchange, reconfiguration, on-orbit assembly/manufacturing) horizons. The successful proposals should articulate the means to connect these two different business cases in a single demonstrator. The proposed demonstrator should represent a risk-taking, disruptive approach to enable new commercial opportunities in space.

The Orbital Mission Study should provide a feasibility study relating to the demonstrator mission (Phase A) and a preliminary design of this mission (Phase B1) outlining system and technology requirements.

In parallel to this, the proposal should outline which hardware and software technologies, as defined in the Mission Study, will be developed by the consortium in order to achieve this level of technology maturation.

As such, each proposal should cover the following areas:

- **Global market & trend analysis:** The proposal shall detail the business cases that will be enabled by the demonstrator and the new market opportunities that will be generated in the space sector in Europe.
- **Transition into the new paradigm:** The Proposal shall explain how the demonstrator will facilitate the smooth transition between the short-term market need and future commercial possibilities through the generation of new modular and reconfigurable, intelligent satellites. Furthermore, the proposed mission and system design shall allow the integration of other functional building blocks into the system at later phases (for example, Phases C and D) of the project. This shall demonstrate increased flexibility before launch compared to conventional systems.
- **TRL increase of critical systems:** The proposal shall not only cover the phase A and B1 studies of the mission, but also identify and undertake the critical hardware developments and technology maturation needed to ensure the viability of the demonstrator in the next phases.

b) Advanced Robotics Planetary Exploration: the next step in exploration will target areas of planets that are hard to reach, such as gullies, cliffs, craters and lava tubes. This requires improved capability in the rover's understanding of its environment (not simply 2D with obstacles, but fully 3D), and capabilities in motion planning and execution which have not previously been demonstrated. This sub-topic aims to integrate the state-of-the-art technology (artificial intelligence, sensing and modelling complex environments, diverse means of locomotion, and cooperative planning and decision making) needed for this application.

The successful proposal should aim to overcome these current constraints by identifying the gaps in technology and knowledge and providing innovative solutions.

In detail, the successful proposal should address the following aspects:

- **Demonstrator:** the design and implementation of an exploration demonstrator to simulate hazardous and/or difficult extra-terrestrial terrain and test the technologies required to plan, navigate, traverse and investigate them.
- **Technology development:** Identification and development/maturation of the critical software and/or hardware technologies needed to enable the exploration of previously inaccessible areas on planetary surfaces. The spin-in of technologies from terrestrial sectors shall be investigated for this purpose.
- **Case Study exploring terrestrial exploitation:** provision a full case study demonstrating how the submitted technology can be exploited on Earth to solve problems in terrestrial sectors and scenarios.
- **Re-use and improvement of the technologies and products of the previous SRC Calls:** inclusion of a dedicated section explaining how to implement and develop the results of the previous SRC Calls, both in terms of building blocks and of system design.

The results of the successful project, coupled with the results of the previous SRC calls, will be crucial in paving the way for future European activities in planetary exploration.

At least two proposals will be selected for subtopic a) and at least of one proposal for subtopic b).

The Commission considers that proposals requesting a contribution from the EU of around 3 million EUR would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

A guidance document will be made available on the Funding & Tenders Portal.

Grants awarded under this topic will be complementary to each other and complementary to grants awarded under other previous SRC topics COMPET-4-2014, COMPET-4-2016 and SPACE-12-TEC-2018. In order to ensure a smooth and successful implementation of this Strategic Research Cluster, the beneficiaries of complementary grants ("complementary beneficiaries") shall join the already established "collaboration agreement". The respective options of Article 2, Article 31.6 and Article 41.4 2 of the [Model Grant Agreement](#) will be applied.

Proposals under this topic may be subject to security scrutiny if they could potentially lead to security-sensitive results that should be classified (see guide for classification available at the Funding & Tenders Portal).

Expected Impact: Space robotics technologies developed under these sub-topics are expected to increase the performance of space missions in a cost-effective manner and enable new business cases considering New Space approaches.

Additionally, for the sub-topic a) the results are expected to:

- Propose multiple new business cases and enable new market opportunities reflected by the paradigm shift from mission-specific solutions to modular, intelligent, flexible spacecraft;
- Increase the viability of the demonstrator(s) through the necessary hardware developments;
- Provide a qualitative and quantitative evaluation of the economical, technical, scientific and performance-related impact and benefits of standardized technologies, in order to tangibly contribute towards emerging regulations governing the commercial use of such technologies in space.

Additionally, for sub-topic b) the results are expected to:

- Improve the scientific yield of planetary missions by increasing accessibility;
- Lead to mission studies for challenging, next-generation planetary exploration;
- Lead to tangible exploitation of planetary exploration technologies in terrestrial applications and vice versa.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Secure and safe space environment

Space capacities are strategically important to civil, commercial, security and defence-related policy objectives. Europe needs to ensure its freedom of action and autonomy. It needs to have access to space and be able to use it safely.

Growing threats are emerging in space: from space debris to cyber threats, the impact of space weather and Near-Earth Objects (NEOs). Europe must draw on its assets and use space capacities to meet the security and safety needs of the Member States and the EU.

Proposals are invited against the following topic(s):

SU-SPACE-21-SEC-2020: Space traffic management

Specific Challenge: The combination of cheaper technology and new investors led by the internet sector is lowering the threshold for access to space. The number of space actors, public and private, is increasing, and with them comes the development of new space technologies and markets (such as reusable launchers, mass produced small satellites, in-orbit servicing and operations, space mining, sub-orbital flights). As a result, the number of objects in orbit will likely increase dramatically in the near future as well as new types of activities are emerging raising concerns for launcher operations, safe access to and operations in space and long-term sustainability of space.

To cope with this evolution, those future space operations from the Newspace may require new technical guidelines or new best practices for “Space Traffic Management” (STM) in order to preserve the space environment. This evolution is currently taking place in the US with the expected involvement of the Department of Commerce on space safety. Europe must be an actor of this change in order to maintain its autonomy for safely accessing and using space.

Scope:

- **Providing networking opportunities** for stakeholders from the private space sector including research entities and the public space sector (space agencies) in order to identify responsibilities and key technologies to manage the increasing number of objects reaching orbit and performing re-entry;
- **Assessing available and needed technologies and capabilities, best practices, standards and guidelines** to develop a STM, including in terms of costs, feasibility and effectiveness, taking into account amongst others experiences from the EU SST and EU SSA, ESA-Cleanspace and Cleansat Programmes as well as international developments in the context of the United Nations (UNOOSA)
- **Proposing a set of STM guidelines and best practices and evaluating their organisation and impact on the operations of spacecraft for space traffic management.**

The Commission considers that proposals requesting a contribution from the EU of EUR 1.50 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Proposals under this topic may be subject to security scrutiny if they could potentially lead to security-sensitive results that should be classified (see guide for classification available at the Funding & Tenders Portal).

Expected Impact:

- A comprehensive overview of technical challenges to be addressed in terms of guidelines and best practices;
- A description of the possible roles of current institutional and industrial actors;
- An assessment of the paths for the SSA evolution to support safe and sustainable space operations;
- An identification of the benefits for the EU space market development, for European sovereignty as well as for international cooperation.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SU-SPACE-22-SEC-2019: Space Weather

Specific Challenge: Commonly occurring space weather events have the potential to impact the performance of critical space and ground infrastructure disrupting operations and communications in multiple sectors of society. Extreme events could have devastating societal and economic consequences with potential costs for disruptions and damages estimated in tens or even hundreds of billions of Euros.

Space weather must be monitored and forecasted just like terrestrial weather. However, current space weather services are generally not capable of forecasting events over several days. A longer forecasting horizon would require access to data from new observation infrastructure coupled with new and improved modelling capabilities. Preparations are underway for future instruments to be placed in suitable vantage points (Lagrange 1 and 5 as well as on Earth orbiting satellites and on ground). The challenge is to prepare for a full exploitation of such data by a renewed effort on modelling and forecasting using currently available data.

The Space Strategy recognises that growing threats emerge in space from space debris to the impact of space weather. Accordingly, the Commission announced that its intention to address threats and vulnerabilities including the impact of space weather on satellites and on ground infrastructure such as transport, energy grids and telecommunication networks.

Scope: Proposals shall address the development of modelling capabilities and/or the delivery of prototype services able to interpret a broad range of observations of the Sun's corona and magnetic field, of the Sun-Earth interplanetary space and of the Earth magnetosphere/ionosphere coupling relying on existing observation capacities.

The goal is to pave the way for forecasting horizons for space weather events in the order of tens of hours or days and to identify potential indicators (or proxies) of extreme events potentially through the joint analysis of interdisciplinary data.

Proposals shall address application domains which may include space as well as terrestrial infrastructure.

Proposals shall include architectural concepts of possible European space weather services in relation to the application domains addressed and they shall demonstrate complementary to and, if relevant, utilize precursor Space Weather services already available through the Space Situational Awareness programme of ESA²⁶ and take into account the global space weather service developments by the World Meteorological Organisation (WMO).

This action is also open to cooperation with international partners with relevant expertise.

²⁶ <http://swe.ssa.esa.int/>

Participation of industry, in particular SMEs, is encouraged, as well as the involvement of post-graduate scientists, engineers and researchers, for example through professional work experience or through fellowships/scholarships as applicable. A guidance document will be published together with this work programme.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Boosting the effectiveness of the Security Union".

Expected Impact:

- Improved scientific understanding of the origin and evolution of space weather phenomena;
- New models and forecasting techniques capable of extending the time horizon of a future space weather forecasting capability to several days;
- Inventory of potential early indicators of extreme space weather events.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SU-SPACE-23-SEC-2019: Advanced research in Near Earth Objects (NEOs) and new payload technologies for planetary defence

Specific Challenge: It is fundamental to improve our understanding of Near-Earth Objects (NEOs) through scientific modelling as well as the development of spacecraft instruments and data exploitation, both for the design of asteroids impact mitigation missions and the assessment of the associated effects.

In addition, in order to conduct spacecraft close proximity operations to NEOs and undertake mitigation demonstration missions, it is necessary to have a number of specific technologies and instruments readily available to conduct missions to asteroids with very weak gravitational fields.

The selection of NEO targets for space missions, either for science or mitigation, must guarantee both technical feasibility and high scientific/mitigation return. In this respect ground-based observations represent an essential means to investigate the physical and dynamical properties of the NEO population as a whole, thus leading to further strengthening the science return of a mission, as well as optimising the choice of mission targets. At present our knowledge of the physical characteristics of the NEO population is only around 20%.

New technologies, such as wide-field high-sensitivity telescopes, will provide in the near future the possibility to detect with enough warning time (from hours to days) the so-called "imminent impactors", i.e. asteroids discovered while in route of collision with the Earth. The vast majority are objects of a few meters in size which are likely to eventually produce meteorites. Performing a physical characterization of these objects before they enter the Earth's atmosphere would provide data needed for calibrating the models used to determine the physical characteristics of the NEO population from ground observational data. The capability to network large telescopes, as well as radar facilities, with such wide-field assets will be key for such physical characterization.

Scope: The aim of this topic is the maturation or adaptation to specific use case of existing modelling capabilities and the development of technologies and instruments in support of missions to asteroids.

Each proposal shall address one or two of the following three sub-topics:

a) Maturation or adaptation to specific use cases of existing modelling capabilities.

These include the modelling of the outcome of a kinetic impactor as a function of assumed physical properties, and the implementation of benchmarking campaigns for the cross-validation of the different impact numerical models. The modelling of the dynamical and physical states of a target NEO (including binary asteroids) and their changes due to the effects of a kinetic impactor, should also be addressed, as well as modelling and testing geophysical surface and regolith processes in the low-gravity regimes of NEOs (this includes also thermal processes and surface composition characteristics).

b) Development of instruments, technologies and associated data exploitation models in support of missions to asteroids.

Payload developments are necessary to increase the knowledge of asteroid physical properties directly influencing the efficiency of a kinetic impactor deflection mission. These should include specific focus on the sub-surface and interior structure, as well as the surface mechanical properties via direct and indirect measurement techniques (such as the response of a surface to the interaction with a lander). Focus should be placed on high-accuracy shape models, surface topography and features, including the impact crater of a kinetic impactor and its surroundings.

Maximum exploitation of scientific and technical data shall be ensured by developing all the necessary algorithms and simulators to be prepared for close-proximity operations and payload data analyses (e.g. shape reconstruction from multiple data sources, performance simulators for radioscience, etc.). Specific focus shall be placed on the conditions required by payload instruments to fulfill the mission objectives.

c) Improvement of our knowledge of the physical characteristics of the NEO population.

Focus is on fostering the physical characterization of NEOs by:

1) the efficient use and pooling of existing large aperture telescopes, radar facilities and data processing capabilities; 2) performing high-quality physical observations and calculation; 3) developing methods for rapid estimation of the orbit of an object and characterization of its physical and dynamical properties; and 4) fostering international collaboration focused on timely follow-up observations of potentially hazardous objects (PHOs).

The proposed project shall coordinate with existing surveys devoted to NEO discovery and radar facilities in order to provide a rapid response system for quickly characterize a small asteroid flying-by or in route of collision with the Earth (imminent impactor).

For all aforementioned sub-topics, proposals shall seek complementarity and synergy with related European initiatives or international coordination efforts such as those undertaken by ESA or in the framework of the UN.

The involvement of post-graduate scientists, engineers and researchers is encouraged, for example through professional work experience or through fellowships/scholarships as applicable.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 4 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Boosting the effectiveness of the Security Union".

Expected Impact:

- Advance our understanding of the dynamical and physical states of a target NEO and their changes due to the effects of a kinetic impactor;
- Advance payload technology, and the associated performance simulators for the thorough characterization of asteroid properties affecting planetary defence missions;
- Advance the capability of timely detection and characterization of potential imminent impactors of Earth.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SU-SPACE-31-SEC-2019: Research and innovation network of governmental users of secure satellite communications

Specific Challenge: Satellite communications is an important tool for public authorities active in domains such as border surveillance and management, crisis and disaster management, detecting and monitoring forest fires, monitoring and controlling illegal activities, protection

of critical infrastructures, and humanitarian aid. This is particularly the case when ground-based communication links are damaged (e.g. earthquakes, hurricanes), absent (such as in remote areas or in the maritime domain), or cannot be trusted (e.g. in Common Security and Defence operations outside the EU). In many of those domains public authorities require secure and guaranteed access to satellite communications. However, many governmental users (e.g. fire brigades, civil protection workers, and border management actors) are currently not benefitting from the full potential in the domain of satellite communications. Research and innovation actions, in particular in terms of user technologies, interoperability and standards need to be developed early enough to enable governmental users to profit from the increasing governmental satellite communications services.

Scope: A network of governmental users of secure satellite communications shall be set up with the aim to establish collaboration on aspects in the user domain of governmental satellite communications, such as research and innovation on user equipment, the study and comparison of existing and innovative use-cases, interoperability and standardisation. The network shall also identify and share good practices in the deployment and use of satellite communications by governmental actors in the Member States and in EU institutions, agencies and entities.

Activities shall be tailored to the priorities of governmental satellite communications users, including, inter alia

- Survey of available satcom user equipment, future user technologies, and potential need for standardisation;
- The study and comparison of existing and innovative use-cases and evolving user needs and requirements, and where relevant and feasible, associated tests in laboratory or field test environments;
- Consolidated long-term roadmap and coordination plan for research and innovation relating to secure governmental satellite communication;
- Workshops, in particular involving relevant entities who are not participants of the consortium;
- Specific training linked to satellite communications, for example to share good practices;
- Cross-border twinning schemes, such as field tests.

Special attention will be given to enhance the competence of potential users in the domain of secure satellite communications, including helping less experienced users to rapidly acquire the know-how accumulated in other countries.

The participation to the network of national representatives appointed by EU Member States, responsible for federating and coordinating the inputs from the respective national civilian users, is mandatory. They shall cooperate with relevant EU agencies and entities involved in

the use of satellite communications or user equipment (e.g. Frontex, GSA, EMSA, ENISA, CEPOL, Europol, Eurojust, EDA, SATCEN, EEAS, JRC).

The Commission considers that one proposal requesting a contribution from the EU in the range of EUR 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Boosting the effectiveness of the Security Union".

Expected Impact:

- Common understanding of user needs, and potential for innovation, including interoperability, and standardisation in the use of satellite communications by EU and Member State users.
- Enhanced synergies in the uptake of governmental satellite communication solutions among users from different disciplines, backgrounds and Member States.
- More efficient use of investments made across the EU in demonstrating, testing and training governmental satellite communication users.
- Outputs from this project may benefit future EU programmes in this domain.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Conditions for the Call - Space 2018-2020

Opening date(s), deadline(s), indicative budget(s):²⁷

Topics (Type of Action)	Budgets (EUR million)			Deadlines
	2018	2019	2020	
Opening: 31 Oct 2017				
DT-SPACE-01-EO-2018-2020 (IA)	9.00			06 Mar 2018
DT-SPACE-07-BIZ-2018 (CSA)	2.00			

²⁷ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

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DT-SPACE-08-BIZ-2018 (CSA)	2.00			
LC-SPACE-02-EO-2018 (CSA)	8.00			
LC-SPACE-03-EO-2018 (RIA)	5.00			
LC-SPACE-14-TEC-2018-2019 (RIA)	8.00			
SPACE-10-TEC-2018-2020 (RIA)	12.00			
SPACE-11-TEC-2018 (RIA)	11.00			
SPACE-12-TEC-2018 (RIA)	18.00			
SPACE-15-TEC-2018 (RIA)	9.00			
SPACE-16-TEC-2018 (RIA)	10.00			
SPACE-20-SCI-2018 (RIA)	10.00			
Opening: 16 Oct 2018				
DT-SPACE-01-EO-2018-2020 (IA)		9.00		12 Mar 2019
DT-SPACE-06-EO-2019 (RIA)		5.00		
DT-SPACE-09-BIZ-2019 (CSA)		2.00		
LC-SPACE-04-EO-2019 (RIA)		8.00		
LC-SPACE-05-EO-2019 (CSA)		2.00		
LC-SPACE-14-TEC-2018-2019 (RIA)		8.00		
SPACE-10-TEC-2018-2020 (RIA)		12.00		
SPACE-13-TEC-2019 (RIA)		10.00		
SPACE-17-TEC-2019 (RIA)		9.00		
SU-SPACE-22-SEC-2019 (RIA)		9.00		
SU-SPACE-23-SEC-2019 (RIA)		6.00		
SU-SPACE-31-SEC-2019 (CSA)		3.00		
Opening: 05 Nov 2019				
DT-SPACE-01-EO-2018-2020 (IA)			9.00	05 Mar 2020
DT-SPACE-25-EO-2020 (RIA)			10.00	
DT-SPACE-26-BIZ-2020 (CSA)			2.00	

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LC-SPACE-18-EO-2020 (RIA)			10.00	
LC-SPACE-19-EO-2020 (CSA)			3.00	
LC-SPACE-24-EO-2020 (CSA)			3.00	
SPACE-10-TEC-2018-2020 (RIA)			14.00	
SPACE-27-TEC-2020 (RIA)			9.00	
SPACE-28-TEC-2020 (IA)			24.00	
SPACE-29-TEC-2020 (RIA)			9.00	
SPACE-30-SCI-2020 (RIA)			9.00	
SU-SPACE-21-SEC-2020 (CSA)			1.50	
Overall indicative budget	104.00	83.00	103.50	

Indicative timetable for evaluation and grant agreement signature:

For single stage procedure:

- Information on the outcome of the evaluation: Maximum 5 months from the final date for submission; and
- Indicative date for the signing of grant agreements: Maximum 8 months from the final date for submission.

Eligibility and admissibility conditions: The conditions are described in General Annexes B and C of the work programme. The following exceptions apply:

DT-SPACE-01-EO-2018-2020	The participation of at least one industrial partner is mandatory.
DT-SPACE-01-EO-2018-2020	The Business Plan shall be submitted as a part of Part B of the proposal. It should be based on a template provided by the European Commission and available in the Participants Portal (Topic conditions and Documents section) and in the submission service.
LC-SPACE-02-EO-2018, SPACE-29-TEC-2020	A maximum of one proposal per sub-topic shall be selected for funding.

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DT-SPACE-06-EO-2019	Participation of at least one partner from a country that has signed a Copernicus Cooperation Arrangement is required ²⁸ .
SPACE-10-TEC-2018-2020	<p>Applicants can only select subtopics listed in group A for the call deadline in 2018.</p> <p>Applicants can only select subtopics listed in group B for the call deadline in 2019.</p> <p>Applicants can only select subtopics listed in group C for the call deadline in 2020.</p> <p>A maximum of one proposal per subtopic shall be selected for funding.</p>
SPACE-12-TEC-2018	<p>No beneficiaries of the grant agreement PERASPERA (640026) will participate in consortia of proposals submitted under this topic of the call for proposals, with the exception of the DLR research institutes.</p> <p>A maximum of one proposal per sub-topic shall be selected for funding..</p>
SPACE-13-TEC-2019	<p>No beneficiaries of the grant agreement EPIC (640199) will participate in consortia of proposals submitted under this topic of the call for proposals, with the exception of the DLR research institutes, Eurospace and SME4Space VZW.</p> <p>A maximum of two projects for the subtopic transversal concepts and technologies shall be selected for funding.</p>
SPACE-16-TEC-2018, SPACE-17-TEC-2019	A maximum of two proposals per sub-topic shall be selected for funding.
SU-SPACE-31-SEC-2019	The participation to the network of national representatives appointed by EU Member States, responsible for federating and coordinating the inputs from the respective national civilian users, is mandatory.
SPACE-27-TEC-2020	<p>No beneficiaries of the grant agreement PERASPERA (640026) or its follow-up grant will participate in consortia of proposals submitted under this topic of the call for proposals, with the exception of the DLR research institutes.</p> <p>At least two proposals for sub-topic (a) and at least one proposal</p>

²⁸

<https://www.copernicus.eu/en/international-cooperation-area-data-exchange>

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	for sub-topic (b) shall be selected for funding.
SPACE-28-TEC-2020	<p>No beneficiaries of the grant agreement EPIC (640199) will participate in consortia of proposals submitted under this topic of the call for proposals, with the exception of the DLR research institutes, Eurospace and SME4Space VZW.</p> <p>The numbers of proposals per subtopic to be selected for funding are as follows:</p> <p>a) Low power electric propulsion: at least three proposals with a at least one proposal per technology line (HET, GIE, HEMPT). The maximum requested EU funding per proposal is EUR 4 million.</p> <p>b) Medium power electric propulsion: at least two proposals with a maximum of one proposal per technology line (HET, GIE, HEMPT). The maximum requested EU funding per proposal is EUR 4.5 million.</p> <p>c) High power electric propulsion: at least one proposals for one of the technology lines (HET, GIE, HEMPT). The maximum requested EU funding per proposal is EUR 3 million.</p>
LC-SPACE-18-EO-2020	At least one proposal per sub-topic shall be selected for funding.

Evaluation criteria, scoring and threshold: The criteria, scoring and threshold are described in General Annex H of the work programme.

Evaluation Procedure: The procedure for setting a priority order for proposals with the same score is given in General Annex H of the work programme.

The full evaluation procedure is described in the relevant [guide](#) published on the Funding & Tenders Portal.

Grant Conditions:

SPACE-12-TEC-2018	Grants awarded under this topic will be complementary to each other and complementary to grants awarded under topics COMPET-4-2014 and COMPET-4-2016. In order to ensure a smooth and successful implementation of this Strategic Research Cluster, the beneficiaries of complementary grants shall conclude a written "collaboration agreement". The respective options of Article 2, Article 31.6 and Article 41.4 2 of the Model Grant Agreement will be applied.
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SPACE-13-TEC-2019	Grants awarded under this topic will be complementary to each other and complementary to grants awarded under topic COMPET-3–2014, sub-topic COMPET-3-2016-a and sub-topic COMPET-3-2016-b ("complementary grants"). In order to ensure a smooth and successful implementation of this Strategic Research Cluster (SRC), the beneficiaries of complementary grants ("complementary beneficiaries") shall conclude a written "collaboration agreement". The respective options of Article 2, Article 31.6 and Article 41.4 2 of the Model Grant Agreement will be applied.
SPACE-27-TEC-2020	Grants awarded under this topic will be complementary to each other and complementary to grants awarded under other previous SRC topics COMPET-4-2014, COMPET-4-2016 and SPACE-12-TEC-2018. In order to ensure a smooth and successful implementation of this Strategic Research Cluster, the beneficiaries of complementary grants ("complementary beneficiaries") shall conclude a written "collaboration agreement". The respective options of Article 2, Article 31.6 and Article 41.4 2 of the Model Grant Agreement will be applied.
SPACE-28-TEC-2020	Grants awarded under this topic will be complementary to each other and complementary to grants awarded under other previous SRC topics: COMPET-3–2014, COMPET-3-2016-a, COMPET-3-2016-b and SPACE-13-TEC-2019 ("complementary grants"). In order to ensure a smooth and successful implementation of this Strategic Research Cluster (SRC), the beneficiaries of complementary grants ("complementary beneficiaries") shall conclude a written "collaboration agreement". The respective options of Article 2, Article 31.6 and Article 41.4 2 of the Model Grant Agreement will be applied.
SPACE-10-TEC-2018-2020	For grants awarded under this topic the Commission or Agency may object to a transfer of ownership or the exclusive licensing of results to a third party established in a third country not associated to Horizon 2020. The respective option of Article 30.3 of the Model Grant Agreement will be applied.
SPACE-10-TEC-2018-2020	For grants awarded under this topic beneficiaries will be subject to the additional exploitation obligations: For a period of up to 4 years after the end of the project, access rights to the use of products and/or processes generated by the project shall be given to European entities, in compliance with

	<p>the signed Grant Agreement and with no legal restrictions and limitations stemming from International Traffic in Arms Regulations (ITAR) or equivalent instruments applicable in other jurisdictions.</p> <p>Applicants must acknowledge and incorporate this obligation in the proposal and Annex I to the Grant Agreement. The respective option of Article 28.1 (and Articles 9 and 30.2) of the Model Grant Agreement will be applied.</p>
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Consortium agreement:

<p>DT-SPACE-01-EO-2018-2020, DT-SPACE-06-EO-2019, DT-SPACE-07-BIZ-2018, DT-SPACE-08-BIZ-2018, DT-SPACE-09-BIZ-2019, DT-SPACE-25-EO-2020, DT-SPACE-26-BIZ-2020, LC-SPACE-02-EO-2018, LC-SPACE-03-EO-2018, LC-SPACE-04-EO-2019, LC-SPACE-05-EO-2019, LC-SPACE-14-TEC-2018-2019, LC-SPACE-18-EO-2020, LC-SPACE-19-EO-2020, LC-SPACE-24-EO-2020, SPACE-10-TEC-2018-2020, SPACE-11-TEC-2018, SPACE-12-TEC-2018, SPACE-13-TEC-2019, SPACE-15-TEC-2018, SPACE-16-TEC-2018, SPACE-17-TEC-2019, SPACE-20-SCI-2018, SPACE-27-TEC-2020, SPACE-28-TEC-2020,</p>	<p>Members of consortium are required to conclude a consortium agreement, in principle prior to the signature of the grant agreement.</p>
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SPACE-29-TEC-2020, SPACE-30-SCI-2020, SU-SPACE-21-SEC- 2020, SU-SPACE-22- SEC-2019, SU- SPACE-23-SEC-2019, SU-SPACE-31-SEC- 2019	
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Call - EGNSS market uptake 2019-2020

H2020-SPACE-EGNSS-2019-2020

The European Global Navigation Satellite System (EGNSS) encompasses the satellite navigation system established under the Galileo programme and the European Geostationary Overlay System (EGNOS).

Galileo is providing improved positioning and timing information with significant positive implications for many European services and users. EGNOS is Europe's regional satellite-based augmentation system (SBAS) that is used to improve the performance and provides information on the reliability of GPS and in the future for Galileo.

The use of satellite navigation has helped drive world economic growth, particularly in high-tech industries. The additional resiliency provided by Galileo is expected to enable a range of new applications and services that will benefit from increased positioning reliability, thus further driving economic growth in Europe and beyond.

For the EGNSS market uptake the development of downstream applications is key. It will enable not only to maximise the adoption of Galileo and EGNOS but also to stimulate the EU GNSS downstream industry competitiveness, while capturing public benefits.

EGNOS is already fully operational and Galileo Initial Services (Open Service, Search and Rescue service and Public Regulated Service) are available. Both systems are providing differentiators that should be leveraged in the solution proposed by the applicant. As examples, EGNOS provides integrity information which is key for safety critical applications. Galileo enables higher accuracy and better multipath mitigation, thanks to dual (or triple) frequency, wide bandwidth signals (AltBOC), data-less (pilot) channels, better accuracy for single-frequency users (NeQuick model). What is also differentiating Galileo from other GNSS is that it is the first constellation to contribute to Cospas Sarsat MEOSAR.

Currently most of the EGNSS innovative applications are integrating different technologies. Further developments in the frame of integration of EGNSS with Earth Observation (EO) systems and other technologies are encouraged in order to deliver added value services fully tailored on end user needs. Optimised system architectures have to be defined to fully exploit the potential of synergies/complementary characteristics of the different systems, providing significant benefits in a number of key market segments and operational scenarios.

Overall, the scope of this call is wider than standalone usage of EGNOS and/or Galileo, it is encouraging innovative use of GNSS and fusion with other sensors and positioning technologies, (e.g. Bluetooth beacons, localisation through Wi-Fi base stations, Inertial measurement units, Digital Video Broadcasting etc.).

This priority will focus on two main activities: development of innovative Galileo and EGNOS enabled applications in different market segments and European GNSS awareness raising and capacity building.

The aim of the first activity under this call is to support the market uptake of European GNSS in Europe and beyond. The innovative applications should leverage the differentiators of EGNOS and Galileo systems: e.g. multi-frequencies, high accuracy, authentication services, better accuracy for single-frequency users. Areas of innovation will include EGNOS and Galileo enabled applications with commercial impact, that will foster green, safe and smart mobility, digitisation, and will also support societal resilience and contribute to the protection of the environment.

The second activity is dedicated to the development of EGNSS competences. The actions will focus on raising awareness and providing opportunities for the creation of networks of industrial relationships. International cooperation is welcome as part of the action, when adding value and increasing the impact.

Overall, these two activities will help to maximise the uptake of Galileo and EGNOS and to exploit the potential of the European GNSS industry, and contribute to growth, competitiveness and jobs in this sector, while capturing public benefits

Galileo activities are also supported via the Fundamental Elements part of the EGNSS programme.²⁹

In accordance with the Commission decision C(2014)4995 this call will be implemented by the European GNSS Agency in indirect management.

Proposals are invited against the following topic(s):

LC-SPACE-EGNSS-1-2019-2020: EGNSS applications fostering green, safe and smart mobility

Specific Challenge: The specific challenge of this topic is to develop innovative EGNSS based applications. These should lead to low emission (CO₂ and air pollutants), safer, more secure, lower cost and higher performance mobility, and transport solutions that respond to the increased mobility needs of people and goods whilst improving transport service continuity.

Scope: Proposals may be submitted in any of the transport areas or propose a multi-mode approach:

- **Aviation:** EGNSS solutions for modernising and improving air operations and traffic management technologies, addressing Communication, Navigation and Surveillance applications, including unmanned vehicles (e.g. GNSS based PBN and GBAS Cat II/III operations, advanced operations for approach and landing, surveillance and integrated

²⁹ <https://www.gsa.europa.eu/gsa/grants>

information management, autonomous air vehicles such as Remotely Piloted Aircraft Systems (RPAS) and Unmanned Aerial Vehicles (UAV).

- **Road:** EGNSS solutions that reduce traffic, optimise fuel consumption and emissions, fostering cheaper, smarter, safer and greener transportation (e.g. automated and driverless cars, connected cars). EGNSS solutions in policy driven applications (e.g. digital tachograph, eCall), as well as innovative tolling services and leveraging Intelligent Transport Systems.
- **Maritime:** EGNSS solutions that reduce emissions in shipping and increase efficiency, safety, and resilience (e.g. with reference to vessels navigation, traffic management, port operations, autonomous vessels).
- **Rail:** EGNSS for cheaper, smarter, higher performance, safer and emission-efficient solutions (e.g. train signalling and control, contributing to the European Rail Traffic Management System, asset management, passenger and crew services, autonomous trains).
- **Public Transport:** EGNSS for managing the public transport fleet in order to enhance the quality of public transportation reduce operational costs reduce traffic and provide savings in time and fuel.
- **Multi-mode:** EGNSS for efficient, safer, more secure and higher performance solutions for multi-mode transport (e.g. hybridization of location solutions, reliable location sharing approaches between transport systems, convergence of the transport infrastructures).

Proposals should be built on the exploitation of the distinguishing features of EGNOS and Galileo, e.g.:

- Multiple-frequencies E1, E5 and E6;
- Galileo specific signal modulation, e.g. AltBOC;
- Galileo Search and Rescue Service;
- Galileo High Accuracy service that will be offered free of charge and Authentication features that will be provided by Galileo, i.e. in the frame of the Open Service authentication (OS NMA);
- Accurate absolute and authenticated time synchronization.

Actions should deliver new innovative applications, with commercial impact and a clear market uptake perspective (a Business Plan is required as part of the proposal). EGNSS should be part and parcel of the envisaged solution(s). However, where a combination of EGNSS with other technologies, such as Earth observation satellite communication or other sensors is required to make the application(s) work, this can be included in the scope.

For proposals under this topic:

- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate researchers (engineers, scientists, and others) and the promotion of gender balance is also encouraged, for example through professional work experience or through fellowships/scholarships when applicable;
- A Business Plan and evidence of user engagement shall be compulsory and shall be provided as part of the proposal, to demonstrate the user need and sustainability of the project.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Building a low-carbon, climate resilient future".

Expected Impact:

- Foster the EGNSS market uptake in transport. It should build on specific features and differentiators of Galileo and EGNOS, demonstrating the advantage of their use in smart and green mobility.
- Contribute to the resource efficient, climate and environmental friendly transport that will be also safe and seamless for the benefit of all citizens, the economy and society.
- Encourage market take-up, taking into account infrastructure and regulatory requirements, coordination of multiple actors and projects.
- Commercialise the products and services developed.

Type of Action: Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

DT-SPACE-EGNSS-2-2019-2020: EGNSS applications fostering digitisation

Specific Challenge: As stated in the Digital Single Market Strategy, the combination of digital technologies (big data, Internet of Things, 5G, high performance computing etc.) with other advanced technologies and service innovation offers huge opportunities for increasing industrial competitiveness, growth and jobs.

Location Based-Services (LBS) segment represents a large and fast-growing market, both in terms of number of devices and of cumulated downstream revenues. Mobile operators and application developers are showing a growing interest in using location data as an enabler for numerous enterprise, consumer and public safety services. GNSS LBS applications are supported by several categories of devices, mainly smartphones and tablets, but also specific equipment such as tracking devices, digital cameras, portable computers and fitness gear. These devices support a multitude of applications tailor-made to satisfy different usage conditions and needs.

The main challenge of this topic is to develop EGNSS applications contributing to digitisation of products and services that will:

- Foster the adoption of EGNOS and Galileo in mass markets and ensure that the benefits will be captured by the users.
- Create applications that will make the best use of EGNSS innovative features such as better multipath resistance, authentication etc.
- Contribute to the competitiveness of the European GNSS industry in the area of mobile applications, with special focus on the innovative role of SMEs.
- Maximise public benefits by supporting the development of applications that will address major societal challenges in focus areas such as health, citizen safety, mobility, smart cities, sustainable resources monitoring and management, regional growth, low-carbon energy infrastructure, operation planning and protection, climate action.

Scope: Actions should deliver new innovative applications, with commercial impact and a clear market uptake perspective (a Business Plan is required as part of the proposal).

The proposed EGNSS applications may integrate digital technologies like Internet of Things (IoT), cloud computing, big data and robotics.

The areas which are identified as especially promising for further EGNSS applications development are commercial Location Based Services, e.g. secure financial transactions; and other solutions that would need time stamp and geo-reference; mobile workforce management, tracking solutions and augmented reality, as well as future telecommunication networks. The applications related to the concept of Smart Cities are also within the scope of this topic.

For all the areas, the development and innovation should build on:

- Galileo features that improve performances;
- Multi-constellation, fusion with other positioning techniques, including sensor fusion and innovative network fusion techniques;
- Authentication services provided by Galileo; and

- Techniques to optimise power consumption.

EGNSS should be part and parcel of the envisaged solution(s). However, where a combination of EGNSS with other technologies is required to make the application(s) work, this is not excluded from the scope.

For proposals under this topic:

- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate researchers (engineers, scientists, and others) and the promotion of gender balance is also encouraged, for example through professional work experience or through fellowships/scholarships when applicable;
- A Business Plan and evidence of user engagement shall be compulsory and shall be provided as part of the proposal, to demonstrate the user need and sustainability of the project.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Digitising and transforming European industry and services".

Expected Impact:

- Contribute to the ongoing digitisation of industry and services that leads to customised products, networking and innovation models that leverage community interaction;
- Leverage Time To First Fix (TTFF) improvement, enhancement of the continuity, accuracy and availability of the proposed solutions;
- Accelerate the market take up and foster the competitiveness of European GNSS application providers that build innovation on chipsets and devices;
- Foster applications building on the capacity of EU providers in the area of machine to machine chipset and modules.
- Commercialise the products and services developed.

Type of Action: Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SU-SPACE-EGNSS-3-2019-2020: EGNSS applications fostering societal resilience and protecting the environment

Specific Challenge: The aim of this topic is to develop innovative EGNSS applications to support societal resilience, safeguard the wellbeing of EU citizens, improve emergency and disaster management as a response to climate related, natural and man-made disasters and ensure green growth that protect the environment while generating economic growth.

The challenge is to make these applications more affordable, easy to use and integrated with other solutions and technologies, including for example earth observation, e.g. Copernicus services, in order to enable new targeted innovative solutions.

The following specific challenges are covered by this topic:

- EGNSS is offering additional accuracy and features, such as the Search and Rescue service (SAR). The current SAR service, provided free of charge by Cospas-Sarsat to national Rescue Coordination Centres, is used by about one million beacon owners for maritime, aviation and leisure applications and over the last 30 years has on average contributed to saving 1300 lives per year. Galileo Forward Link Service initial service was declared operational in 2016 and the unique Return Link service is planned to be launched in 2018, delivering acknowledgement of reception of the distress alarm. Emergency services, disaster early detection and efficient management can also benefit from increased accuracy and added value provided by other sensors.
- The power networks, telecommunication networks and financial transactions³⁰ are today synchronised, many of them using GNSS. These networks are becoming more and more distributed (e.g. distributed power generation of renewable energies), interconnected and more demanding in terms of synchronisation performances (e.g. in 4G-LTE and future internet), or requiring authenticated solutions as for the financial transaction time stamping. The specific challenge is in this case to build on the enhanced capabilities offered by Galileo that will provide high accurate timing information and authentication services, to develop a new generation of high performing, reliable and EU independent timing and synchronisation applications that can cope with these emerging and demanding needs. Integrity and trustworthiness of the synchronization mechanism offered by GNSS should also be addressed.
- Precision agriculture, mapping and surveying have been the pioneers in the use of GNSS since the early years. Innovative EGNSS applications in agriculture and surveying should take into account the possibility to minimise the adverse consequences of climate change and the impact on the environment (e.g. fertiliser use and air quality). Other EGNSS differentiators, like multiple frequencies and the Galileo High Accuracy service that will be offered free of charge are contributing to enabling EGNSS innovative solutions, including in challenging environments.

³⁰ Cf. also Article 50 of Directive 2014/65/EU on Markets in Financial Instruments.

Scope: Proposals may address social and professional applications. Promising areas of activities are:

- Applications supporting e-health, safety and emergency management;
- Search and Rescue applications, including tracking of distress situations and response management; resilience and management in crisis situations following a disaster in a context where conventional means are no longer available (telecommunications in particular);
- Emergency and disaster management;
- Management and related operation of critical infrastructure (e.g. electricity network, telecommunication networks, financial transactions), timing and synchronisation;
- Efficient Agriculture: Automated machine guidance, precision farming and machine control;
- Surveying and Mapping: Land survey, marine survey, cadastral and geodesy, and construction.

For all the professional areas, the development and innovation should build on:

- Multiple-frequencies E1, E5 and E6;
- Galileo specific signal modulation, e.g. AltBOC;
- Galileo High Accuracy service that will be offered free of charge and Authentication features that will be provided by Galileo;
- Fusion with other data, such as from EO satellites or other in-situ sensors.

Actions should deliver new innovative applications, with commercial impact and a clear market uptake perspective (a Business Plan is required as part of the proposal). EGNSS should be part and parcel of the envisaged solution(s). However, where a combination of EGNSS with other technologies is required to make the application(s) work, this is not excluded from the scope.

For proposals under this topic:

- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate researchers (engineers, scientists, and others) and the promotion of gender balance is also encouraged, for example through professional work experience or through fellowships/scholarships when applicable;
- A Business Plan and evidence of user engagement shall be compulsory and shall be provided as part of the proposal, to demonstrate the user need and sustainability of the project.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

This topic contributes to the Horizon 2020 focus area "Boosting the effectiveness of the Security Union".

Expected Impact:

- Develop highly innovative applications taking advantage of Galileo and EGNOS differentiators in order to decrease the barriers to access such professional applications, reduce the price and increase the effectiveness of the solution, facilitate its use and increase the number of users;
- Commercialise the products and services developed;
- Proposals addressing Galileo SAR service should leverage the Forward and Return Link Services to improve the users' safety and efficiency of the rescue activity by reducing the time to accurately locate the distress alert;
- Emergency and disaster management applications should target integration of different sensors and position sources to identify, locate and react in critical situations, as well as delivering efficient response to ensure the wellbeing of citizens and monitor the infrastructure;
- Innovative GNSS applications in agriculture improving the productivity and decreasing the negative environmental impact;
- Timing and synchronisation applications focussing on emerging network synchronisation needs in terms of accuracy and robustness, while reducing EU dependency from other GNSS.

Type of Action: Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-EGNSS-4-2019: Awareness Raising and capacity building

Specific Challenge: Extensive GNSS applications combined with other technologies require innovation as well as the establishment of standards and rules.

The challenge is to build a mechanism to leverage EGNSS excellence in particular of SMEs and universities, facilitate EGNSS investments and to foster market uptake. Exploiting the

potential of EGNSS products by maximising and spreading the benefits of EGNSS innovation is vital for Europe's competitiveness and its ability to address societal challenges in the future. The capacity building and awareness rising around EGNSS applications, creation of strategic partnership towards commercialisation and achieving a critical mass of EGNSS applications success stories would attract investment from Europe and beyond.

The main aim of this topic is to support building of industrial relationships by gathering private and public institutions around services offered by EGNSS and related applications.

Scope: The proposals should aim at the development of EGNSS competences existing and emerging in different EU Member States and Associated Countries.

The actions should focus on EGNSS dissemination, awareness-raising and communication, as well as provide opportunities for the creation of networks of industrial relationships in Europe and also globally. By doing so the action should be achieving a critical mass of EGNSS applications success stories, demonstrating the advantages and differentiators of EGNSS services and making it an attractive option for private investors in Europe and also globally.

Technology promotion activities can include incentive schemes in the form of financial support to third parties for innovative applications developed by companies and entrepreneurs and based on the EGNSS that will promote the uptake of satellite navigation downstream applications across Europe and globally.

International cooperation is welcome for when adding value and increasing the impact of the action.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

The Commission considers that proposals requesting a contribution from the EU of between EUR 0.5 and 1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Support the competitiveness of EU industry by identifying strategic partners and by developing market opportunities in Europe and also globally. The creation of a network of EGNSS products market champions will leverage the country/region's assets in terms of research, innovation, and know-how, by supporting the growth of EGNSS industry and SMEs and by fostering cooperation between SMEs, industry leaders, investors, and research organizations.
- Foster the emergence of new downstream applications based on either Galileo and/or EGNOS and therefore to support the EU GNSS industry in Europe and also globally.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

SPACE-EGNSS-5-2020: EGNSS applications for public authorities' pilot

Specific Challenge: Innovation procurement can drive the R&D and deployment of innovative solutions from the demand side through respectively pre-commercial procurement (PCP). This can open new market opportunities for companies in Europe, can contribute to speeding up public sector modernisation and can help to tackle societal challenges with innovative/breakthrough solutions for the benefit of the citizen.

Satellite navigation technology is an increasingly common component of innovative applications in different market segments. Involvement of public institutions is key in fostering the EGNSS adoption. Nowadays the maturity of EGNSS based solutions and their increased accessibility provide significant contribution to the achievement of Sustainable Development Goals of the governments.

The main challenge of this topic is to deepen user integration and thus foster exploitation of EGNSS applications to match the needs of public authorities at national, regional or local levels.

The innovative EGNSS solutions developed through this action should have been tested and have demonstrated success in smaller scale settings and have not yet been deployed on a large scale.

Scope: The objective is to launch demand-driven actions by public authorities aiming at customising EGNSS applications for their needs. Transnational cooperation has a key role to play in this context, as it can facilitate knowledge transfer and optimisation of resources for public authorities. Proposals should be building on procurement needs of the participating organizations. The proposals should support the EGNSS market take-up across Europe and demonstrate a sustainability of solutions beyond the lifespan of the proposed project. The choice of EGNSS market segment and application is left to the proposer. A non-exhaustive list of possible applications is presented below:

- EGNSS for mobility as a service, cooperative ITS, public transport and smart cities,
- Implementation of Performance Based Navigation procedures,
- Integration of EGNSS into U-Space concept for drones,
- Helicopter emergency medical services with EGNOS capabilities (operations and equipment).
- Public rescue services with Galileo SAR capable helicopters, boats and drones
- EGNSS to support port operations,
- Monitoring of infrastructure with EGNSS (rail, road, critical infrastructure)

The consortium should engage public procurers from each country represented in the consortium (at national, regional or local level) that have responsibilities and budget control in the relevant EGNSS market segment.

Proposals should be built on the exploitation of the distinguishing features of EGNOS and Galileo signals and operational advantages in downstream applications.

EGNSS should be part and parcel of the envisaged solution(s). However, where a combination of EGNSS with other technologies is required to make the application(s) work, this is not excluded from the scope.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this topic.

The Commission considers that proposals requesting a contribution from the EU of between EUR 1 and 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: Activities related to this topic should contribute to:

- The establishment of buyer groups for EGNSS application;
- Creation of EGNSS-enabled national, regional or local applications in support of public authorities;
- Fostering the emergence of similar EGNSS actions in smart specialisation strategies;
- Establishment of sustainable supply chains for delivery of downstream EGNSS applications to public authorities;
- Smart use of the procurement budget to remove supplier lock-in and obtain more open, standardized and better “value for money” solutions;
- Increase in quality, and decrease in prices, of EGNSS products and services;
- Increased exploitation of IPRs and R&D results;
- Creation of growth and jobs in Europe.

Type of Action: Pre-Commercial Procurement

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Conditions for the Call - EGNSS market uptake 2019-2020

Opening date(s), deadline(s), indicative budget(s):³¹

Topics (Type of Action)	Budgets (EUR million)		Deadlines
	2019	2020	
Opening: 16 Oct 2018			
DT-SPACE-EGNSS-2-2019-2020 (IA)	4.00		05 Mar 2019
LC-SPACE-EGNSS-1-2019-2020 (IA)	10.00		
SPACE-EGNSS-4-2019 (CSA)	2.00		
SU-SPACE-EGNSS-3-2019-2020 (IA)	4.00		
Opening: 05 Nov 2019			
DT-SPACE-EGNSS-2-2019-2020 (IA)		4.00	05 Mar 2020
LC-SPACE-EGNSS-1-2019-2020 (IA)		10.00	
SPACE-EGNSS-5-2020 (PCP)		3.00	
SU-SPACE-EGNSS-3-2019-2020 (IA)		4.00	
Overall indicative budget	20.00	21.00	

Indicative timetable for evaluation and grant agreement signature:

For single stage procedure:

- Information on the outcome of the evaluation: Maximum 5 months from the final date for submission; and
- Indicative date for the signing of grant agreements: Maximum 8 months from the final date for submission.

Eligibility and admissibility conditions: The conditions are described in General Annexes B and C of the work programme. The following exceptions apply:

DT-SPACE-EGNSS-2-2019-2020, LC-	The Business Plan shall be submitted as a part of Part B of the proposal. It should be based on a template provided by the
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³¹ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts for the 2020 budget are indicative and will be subject to separate financing decisions to cover the amounts to be allocated for 2020.

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SPACE-EGNSS-1-2019-2020, SU-SPACE-EGNSS-3-2019-2020	European Commission and available in the Participants Portal (Topic conditions and Documents section) and in the submission service.
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Evaluation criteria, scoring and threshold: The criteria, scoring and threshold are described in General Annex H of the work programme.

Evaluation Procedure: The procedure for setting a priority order for proposals with the same score is given in General Annex H of the work programme.

The full evaluation procedure is described in the relevant [guide](#) published on the Funding & Tenders Portal.

Consortium agreement:

DT-SPACE-EGNSS-2-2019-2020, LC-SPACE-EGNSS-1-2019-2020, SPACE-EGNSS-4-2019, SU-SPACE-EGNSS-3-2019-2020	Members of consortium are required to conclude a consortium agreement, in principle prior to the signature of the grant agreement.
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Fast track to innovation

Full details on this pilot are provided in the separate call for proposals under the Horizon 2020 Work Programme Part - Fast Track to Innovation Pilot (Part 18 of this Work Programme).

European Innovation Council (EIC) prize: "Low cost Space Launch"

Full details on the European Innovation Council (EIC) prize: "Low cost Space Launch" is provided in Part 17 of this Work Programme. This work programme part contributes a co-funding for this prize.

Other actions (2018-2020)

1. ESA engineering support³²

Cooperation with ESA is within the spirit of Horizon 2020 space which explicitly foresees that activities shall be implemented in conjunction with ESA and Member States activities. Such cooperation would be desirable on actions that cannot be addressed in an efficient way through the standard Horizon 2020 process and to reinforce synergies of EU and ESA resources thus allowing for a more comprehensive approach towards the space sector.

This is especially true for activities pertaining to high technology readiness levels, in particular in orbit validation/demonstration. Such activities are close to satellite development and entail high risks and uncertainties. Accordingly, they need structured project and technical management by a competent and specialised engineering team.

ESA is well-placed in order to provide the relevant support. Moreover, the implementation of Horizon 2020 space could benefit from synergies with similar IOD/IOV activities managed by ESA.

Accordingly, ESA shall be in charge of project and technical management for all selected projects resulting from action 14: "In-orbit validation/demonstration – Mission design, integration and implementation".

A non-exhaustive list of possible tasks could include: support to the preparation of a guidance document to be published together with the calls; supervision of projects in compliance with the reviews foreseen in the guidance document; interface between experiment providers and platform providers as well as interface with the launch service provider.

Implementation: Indirect management by the European Space Agency under contribution agreement³³

Type of Action: Contribution agreement with an implementing entity (indirect management)

Indicative timetable: Fourth quarter of 2018

Indicative budget: EUR 6.00 million from the 2018 budget

2. InnovFin Space Equity Pilot (ISEP)

The potential of the EU's space programmes, Copernicus, EGNOS and Galileo, and of the wider possibilities offered by space data and space technologies must be better exploited to optimise the benefits that space can bring to society and the wider EU economy. Enabling measures and capacity-building in all Member States and at EU level are needed to foster a

³² This action shall be complementary and coherent with actions 4 and 14. All three actions shall, therefore, be implemented by ESA under one single contribution agreement.

³³ Since the contribution agreement is stipulated in the new EU Financial Regulation, the condition for its use shall be the effective entry into force of the latter.

dynamic space innovation ecosystem and a more favourable regulatory and business environment. This, in turn, will incentivise the private sector to have more appetite for investments in the space domain and encourage businesses to develop more innovative, space-related products and services. Measures are already being taken to support SMEs, start-ups and young entrepreneurs through business incubators and the use of prizes and competitions (such as the Copernicus and Galileo Masters), and via initiatives covering the various cycles of business development (for example, space technology accelerators providing seed-stage support).

To help improve access to risk finance for innovative enterprises in the space domain, ISEP will invest in venture capital and other risk-capital funds focused on innovative SMEs and small midcaps that aim to commercialise new products and services linked to space data and space technologies.

Expected impact: An increase in the risk capital available to invest in SMEs and small midcaps operating in the space domain. The indicators are the number of agreements signed with financial intermediaries (i.e., risk capital funds), the volume of investments made in SMEs and small midcaps, and the number of SMEs and small midcaps invested in.

Selection procedure: For risk-capital funds acting as financial intermediaries: the call for expression of interest issued by EIF, open at http://www.eif.org/what_we_do/equity/single_eu_equity_instrument will be modified in the third quarter of 2018 to encompass ISEP.

For investments by a selected fund in an enterprise: according to the investment strategy and procedures of the fund concerned.

Type of Action: Financial Instrument

Indicative timetable: Third quarter of 2018

Indicative budget: EUR 6.00 million from the 2018 budget and EUR 7.00 million from the 2019 budget and EUR 7.00 million from the 2020 budget (Additional allocation from the Access to risk finance budget-line (EUR 30.00 million))

3. Programmatic Support Actions for the Strategic Research Clusters³⁴

The objective is to propose a continuation of the Programme Support Activity (PSA), for the implementation of the Electric Propulsion and Space robotics technologies Strategic Research Clusters (SRCs) in Horizon 2020. The overall budget for such SRCs could be in the range of several tens of millions of euros and should achieve a full in-orbit validation of the electric propulsion systems and Space robotic applications developed at pre-commercial level during the SRCs. This validation is planned to be achieved in the 2021-2027 period.

³⁴ This grant will be awarded without call for proposals in line with Article 190(1)(e) of the Rules of applications of Regulation (EU, Euratom) 966/2012, Regulation No 1268/2012 and Article 11(2) of the Rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)", Regulation (EU) No 1290/2013.

Further information on the concept of a Strategic research cluster in Horizon 2020 is available at <http://ec.europa.eu/enterprise/policies/space/research>.

The PSA consortia will ensure the coordination and necessary exchange of information and knowledge between the different projects within the Electric Propulsion and Space robotics technologies SRCs, respectively, by providing:

- Assessment of the various activities and results of the respective SRCs projects³⁵.
- Update of the master plan, as needed, to coordinate all the activities for the duration of the respective SRCs.
- Identification of the activities required to address the challenge of the respective topics.
- Identification and planning of the activities required for in-orbit demonstration and validation.
- Coherence of actions within the fields of Electric Propulsion and Space Robotics respectively with the aim to enhance the competitiveness of the European space industry in these fields on the global market and to ensure validated technologies for potential use in the EU programmes.

Implementation: Two grants to identified beneficiary – Coordination and support action

Legal entities:

The consortium of the EPIC project, <http://epic-src.eu/epic-partners/>

The consortium of the PERASPERA project, http://www.h2020-peraspera.eu/?page_id=21

Type of Action: Grant to identified beneficiary - Coordination and support actions

Indicative timetable: Third quarter 2019

Indicative budget: EUR 6.00 million from the 2019 budget (EUR 3M for each grant)

4. In-orbit demonstration/validation – launch services³⁶

To ensure European non-dependence and competitiveness in technologies, there is a clear need for regular IOD/IOV service in Europe. Space flight heritage in real conditions and environment is often required to de-risk new technologies, products, concepts, architectures, services and operations techniques be that it for unique or recurrent, institutional or commercial missions.

³⁵ See Article 6 of Guidelines for SRC's, <https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/compet-03-2014.html>

³⁶ This action shall be complementary and coherent with actions 1 and 14. All three actions shall, therefore, be implemented by ESA under one single contribution agreement.

A regular solution for common flight ticket actions (management, spacecraft, launch and operations) remains a challenge.

Launch service is an indispensable element of the entire value chain of space and has been recognised as an area of strategic importance towards the direction of Europe's non-dependence.

Actions under this area will provide the launch services for:

- selected IOD/IOV projects resulting from action 14: "In-orbit validation/demonstration – Mission design, integration and implementation";
- selected actions underpinning IOD/IOV and small spacecraft rideshare launch needs (fast scheme) in coordination with other European activities.

Regarding the former, selected projects from action 14: "In-orbit validation/demonstration – Mission design, integration and implementation" will be managed by ESA who shall interface with the European launch service provider in order to identify the detailed launch service needs (flight ticket) corresponding to the projects (e.g. launch slots, technical and programmatic aspects, mission analysis). This interface will be done on the basis of the available resources for this action and with a view to optimising available European planned launch solutions. The result will be a dedicated work order to the European launch service provider for each project. The work order will be managed by ESA during the lifetime of the project.

Regarding the latter, actions shall focus on enabling affordable, regular and standardised rideshare launch services for small spacecraft. This would maximise IOD/IOV launch opportunities as IOD/IOV experiments often rely on small spacecraft. Accordingly, this action shall support the Proof of Concept (POC) demonstration flights for VEGA and Ariane 6 in 2019 and 2021³⁷. Such support shall be limited, shall not be associated to any specific mission aboard the flights and shall be conditional to the successful completion of the mission aggregate and funding model thus not incurring any cost overruns. Member States shall be consulted on the exact actions and the maximum amount to be allocated.

The actions will provide flight opportunities with European manufactured launchers which include the mission analysis, the verification of interfaces between the spacecraft and the launcher, the preparation of launch campaign and the flight up to the injection of the spacecraft on its required orbit.

To optimise opportunities and to take into account future needs, complementarity with available launch slots and related initiatives by Member States, ESA and other stakeholders shall be sought through an expert group.

³⁷ The proof of concept flights planned in the ESA Light Sats, Low cost, launch opportunities (LLL) initiative include the VEGA Small Spacecraft Mission Service (SSMS) and Ariane 6 Microsat Launch Share (MLS).

Implementation: Indirect management by the European Space Agency under contribution agreement³⁸

Type of Action: Contribution agreement with an implementing entity (indirect management)

Indicative timetable: Fourth quarter of 2018

Indicative budget: EUR 39.00 million from the 2018 budget

5. Improving the performance of Space surveillance and tracking (SST) at European level

Currently the space surveillance and tracking capabilities in Europe are fragmented and largely dependent on space surveillance systems controlled by third States. In order to ensure the protection of European infrastructure in space, as well as to move towards a greater autonomy of Europe in its access to and use of space, there is need for coordinated efforts at Union level in the field of SST, in particular in the areas of service provision, networking of assets and sensors.

The Decision No 541/2014/EU of the European Parliament and of the Council of 16 April 2014 establishes a Framework for Space Surveillance and Tracking Support (SST)³⁹.

The Consortium resulting from the implementation of the support framework for the emergence of an SST capacity at European level has established its own dedicated implementation structure in order to manage related Union support. Therefore, the above Consortium⁴⁰ shall be considered as the identified beneficiary of the support to SST under Horizon 2020 and other Union funding programmes. This activity consists in analysing, assessing and undertaking the necessary research, development and innovation activities with the specific aims of (1) supporting the pooling of national resources on the SST objectives outlined in the aforementioned Decision and coinciding with the Horizon 2020 objectives and challenges related to protecting Europe's investment made in space infrastructure; (2) supporting the upgrade and development of assets, in particular radars, lasers and telescopes as well as data processing, operating centres, network and infrastructure, and front desk, operated by Member States participating in the SST Support Framework in line with the needs of services provisions through 1SST grant⁴¹, answer to Annex VII⁴², the Union SST

³⁸ Since the contribution agreement is stipulated in the new EU Financial Regulation, the condition for its use shall be the effective entry into force of the latter.

³⁹ OJ L 158 of 27 May 2014, p. 227–234

⁴⁰ In line with recital 24 of the Decision No 541/2014/EU, article 129 of the Financial Regulation (Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council) and article 193 of its Rules of Application (Commission Delegated Regulation (EU) No 1268/2012) this action may be financed jointly from separate source programmes, namely Horizon 2020 Framework Programme (Regulation (EU) No 1291/2013 of the European Parliament and of the Council), the Copernicus programme (Regulation (EU) No 377/2014 of the European Parliament and of the Council) and the European Satellite Navigation programmes (Regulation (EU) No 1285/2013 of the European Parliament and of the Council).

⁴¹ Grant Agreement for 1SST 2018-20

⁴² Report answering request in Annex VII of the 1SST2016-17 GA, Version 2.0, 28/09/18

development plan⁴³ and the architecture trade-off⁴⁴; and (3) achieving significant economies of scale by joining related resources from Horizon 2020 (LEIT/space and secure societies), European Satellite Navigation Programmes and Copernicus, in addition to the cumulative national investment of the Member States participating in the SST support framework, which largely exceeds the Union contribution through the above Union funding programmes. As a result, the Union contribution covers only a limited part of the national costs related to SST activities and assets.

The aim is to improve the overall performance of the SST services and ensure, in the long-term, a high level of performance and appropriate autonomy at Union level. The activity should lead to connected SST assets with high added value with regard to coverage, cataloguing of space objects and performance indicators (including service provision quality) allowing for improved quality and performance of SST in the future. Once these sensors have been networked and introduced in the operational Union SST chains, they will lead to a better orbital coverage and the collection of improved data, in terms of both quality and quantity. The integration of upgraded and developed sensors should be implemented in accordance with the needs for complementarity and optimisation of the SST architecture while taking into account the cost limitation. This activity will also lead to closer interaction and complementarity among the various National Operations Centres and optimisation of the SST architecture thus achieving economies of scale while avoiding duplication.

This activity may involve the use of classified background information or the production of security sensitive foreground information. As such, certain deliverables may require security classification. The final decision on the classification of deliverables is subject to the security evaluation⁴⁵.

The activity will contribute to achieving the objectives set out in Annex 1 to the Commission Implementing Decision⁴⁶ on a coordination plan for the SST support framework and the procedure for participation of Member States^{47, 48}. Impact achieved from the action execution will be assessed on the basis of the indicators and reporting obligations foreseen in the above Commission Implementing Decision.

The option of full purchase costs of equipment, infrastructure or other assets could be included in the GA if/when duly justified, in conformity of "Article 6.2 D.2" of the Horizon 2020 Model Grant Agreement.

⁴³ Development plan D9.1 2-3SST2016-17, Version 1.0, 05/02/2019 and the necessary adaption following the Mid-term review of 19-20/02/2019

⁴⁴ Architecture trade-off, D7.4 2-3SST2016-17, Version 1.0, 05/02/2019 and the necessary adaption following the Mid-term review of 19-20/02/2019

⁴⁵ Procedure on the Security Evaluation of SST Grants; Ref. Ares(2016)2653609 - 08/06/2016, to be updated to include the new Member States.

⁴⁶ COM(2016)8482 of 19.12.2016

⁴⁷ http://ec.europa.eu/growth/sectors/space/security_en

⁴⁸ In conjunction with the respective cumulative budget from Copernicus, EGNSS, and from Horizon 2020 LEIT Space and Societal Challenge 7 on secure societies

This activity contributes to the Horizon 2020 focus area "Boosting the effectiveness of the Security Union".

The identified beneficiary for this grant⁴⁹ is the consortium resulting from the implementation of the SST support framework within the meaning of Article 7(3) of Decision No 541/2014/EU comprising entities designated by participating Member States^{50, 51} and the EU SATCEN^{52, 53}.

Specific grant awarded under the Framework Partnership Agreement on Space Surveillance and Tracking for Research and Innovation Action. The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts D and H of the General Annexes.

Proposals submitted under this action may be subject to security scrutiny.

Legal Entities: The consortium resulting from the implementation of the SST support framework within the meaning of Article 7(3) of Decision No 541/2014/EU comprising entities designated by participating Member States^{54, 55} and the EU SATCEN^{56, 57}.

Type of Action: Specific Grant Agreement

Indicative timetable: Fourth quarter of 2019 and first quarter 2020 respectively

Indicative budget: EUR 4.90 million from the 2019 budget and EUR 65.70 million from the 2020 budget

6. Galileo Evolution, Mission and Service related R&D activities

While the first generation of Galileo is being deployed, it is essential to guarantee that Galileo will remain competitive and cost-effective in the long term. Therefore, new and innovative

⁴⁹ In conjunction with the respective cumulative budget from Copernicus, EGNSS, and from Horizon 2020 LEIT Space and Societal Challenge 7 on secure societies

⁵⁰ http://ec.europa.eu/growth/sectors/space/security_en

⁵¹ Article 195(d) FR allows award of a grant without the call for proposals to "bodies identified by a basic act, within the meaning of Article 58, as beneficiaries or to bodies designated by Member States, under their responsibility, where those Member States are identified by a basic act as beneficiaries;".

⁵² Article 8 of Decision No 541/2014/EU: "*The European Union Satellite Centre (SATCEN) may cooperate with the consortium [...]*".

⁵³ Article 195(f) FR provides for an additional exception to calls for proposals "for activities with specific characteristics that require a particular type of body on account of its technical competence, its high degree of specialisation or its administrative powers, on condition that the activities concerned do not fall within the scope of a call for proposals;".

⁵⁴ http://ec.europa.eu/growth/sectors/space/security_en

⁵⁵ Article 195(d) FR allows award of a grant without the call for proposals to "bodies identified by a basic act, within the meaning of Article 58, as beneficiaries or to bodies designated by Member States, under their responsibility, where those Member States are identified by a basic act as beneficiaries;".

⁵⁶ Article 8 of Decision No 541/2014/EU: "*The European Union Satellite Centre (SATCEN) may cooperate with the consortium [...]*".

⁵⁷ Article 195(f) FR provides for an additional exception to calls for proposals "for activities with specific characteristics that require a particular type of body on account of its technical competence, its high degree of specialisation or its administrative powers, on condition that the activities concerned do not fall within the scope of a call for proposals."

mission concepts are to be developed and studied in order to ensure that the second generation fulfils the evolving needs of users as analysed in the Galileo mission evolution process

Actions under this area will also serve to study and develop concepts for new Galileo services as well as for the evolution of the currently defined services.

For 2019 the Actions related to EGNSS services will cover the following theme:

- Innovative Concepts.

Procurements affected by GNSS security aspects require restricted participation.

Type of Action: Public Procurement - Framework contracts and/or calls for tender

Indicative timetable: Second quarter 2019 and second quarter 2020

Indicative budget: EUR 2.60 million from the 2019 budget (indicative number of contracts: Y) and EUR 1.80 million from the 2020 budget

7. EGNOS, Mission and Service related R&D activities

EGNOS is a fully operational System since 2011. Evolution of the currently provided services, namely the Open Service, Safety of Life and EGNOS Data Access Service (EDAS) are already being considered, such as the extension of the Safety of Life service to other user communities than civil aviation. Furthermore, innovative concepts for new services are to be developed, for example looking into the exploitation of existing band-width, so that additional messages can be broadcasted (in L1 and in the future in L5).

Finally, since EGNOS is a System developed in accordance to the international SBAS standards, it is necessary to make provisions for analyses of mission or service adaptations which may be needed due to changes on those international standards.

Procurements affected by GNSS security aspects require restricted participation.

Type of Action: Public Procurement - Framework contracts and/or calls for tender

Indicative timetable: Second quarter 2019, second quarter 2020

Indicative budget: EUR 0.40 million from the 2019 budget (indicative number of contracts: Y) and EUR 0.20 million from the 2020 budget

8. GNSS evolution, infrastructure-related R&D activities

The GNSS infrastructure-related R&D activities under Horizon 2020 will be implemented by ESA in indirect management in accordance with Article 58(1)(c) of the Regulation (EU, Euratom) No 966/2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 (the "Financial Regulation").

Consistency of the R&D actions implemented by ESA with the Galileo/EGNOS work programmes and the mission evolution targets is ensured by the Long Term Plan for Infrastructure related R&D activities.

The following activities will be supported through funding by the Space theme in 2018 and 2019:

1. Galileo evolution phase System/Segment Phase B2 activities.
2. GNSS general research and technology.

These activities in 2018 and 2019 will be implemented by ESA under the H2020 Delegation Agreement between the Commission and ESA.

According to the H2020 EC-ESA Delegation Agreement on Participation conditions, participation to procurement actions may be limited to entities providing the satisfactory security guarantees required for the particular action. In such case participation shall in principle be open only to entities established in the EU Member States. Participation of entities established in H2020 associated countries or in third countries will be decided on a case by case basis with the approval of the work plan

Implementation: Indirect management by the European Space Agency under Delegation Agreement with the Commission.

Type of Action: Indirect Management by ESA

Indicative timetable: First quarter 2018, first quarter 2019 and first quarter 2020 respectively

Indicative budget: EUR 36.00 million from the 2018 budget (including ESA remuneration costs) and EUR 31.00 million from the 2019 budget (including ESA remuneration costs) and EUR 10.00 million from the 2020 budget (including ESA remuneration costs)

9. Cooperation among NCPs⁵⁸

The network of Space NCPs should facilitate trans-national co-operation between NCPs within the Space domain with a view to identifying and sharing good practices and raising the general standard of support to programme applicants, taking into account the diversity of actors that make up the constituency of this domain.

Support will be given to a consortium of formally nominated NCPs in the area of Space. The activities will be tailored according to the nature of the area, and the priorities of the NCPs concerned. Various mechanisms may be included, such as joint workshops, enhanced cross-border brokerage events or specific training linked to the Space domain and twinning

⁵⁸ This grant will be awarded without call for proposals in line with Article 190(1)(e) of the Rules of applications of Regulation (EU, Euratom) 966/2012, Regulation No 1268/2012 and Article 11(2) of the Rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)", Regulation (EU) No 1290/2013.

schemes. The network should also consider measures for widening participation across Europe.

The focus throughout should be on issues specific to the Space part of Horizon 2020 and should not duplicate actions foreseen in the NCP network for quality standards and horizontal issues under ‘Science with and for Society’.

The consortium should have a good representation of experienced and motivated NCPs.

NCPs from EU Member States or Associated Countries choosing not to participate as a member of the consortium should be identified and this should be documented in the proposal. These NCPs are nevertheless invited and encouraged to participate in the project activities (e.g. workshops), and the costs incurred by the consortium for such participation (e.g. travel costs paid by the consortium) may be included in the estimated budget and be eligible for funding by the Commission.

Legal entities:

The consortium implementing the current COSMOS2020 grant modified following a request for expression of interest, (<http://ncp-space.net/archive-of-pages/about-cosmos/partners-organisations/>)

Type of Action: Grant to identified beneficiary - Coordination and support actions

Indicative timetable: Fourth quarter 2018

Indicative budget: EUR 0.60 million from the 2018 budget

10. Studies & Communication

Activities shall support the implementation of the Space strategy for Europe⁵⁹ and Horizon Europe and may include studies, support and communication activities that are needed to analyse and enhance the EU space R&I environment, for example

- higher education in the EU versus needs of the space R&I community;
- dissemination of scientific results;
- analysis of the portfolio of EU-funded projects in the field of space and their spin-in and spin-off potential;
- collection of project feedback, in particular with respect to key exploitable results;
- organisational support for consulting the R&I stakeholders community on R&I needs;
- production and dissemination of communication material and the organisation of events related the European Space Policy, European R&I agendas and Horizon Europe.

⁵⁹ COM(2016) 705 final

Activities may include surveys as appropriate implemented through public procurement, and/or appointing (groups of) independent experts. These limited numbers of contracts may be implemented on the basis of framework contracts, in order to further ensure that the Commission is provided with appropriate and timely analyses, which in turn will facilitate the proper integration of policy studies into the preparation of new policy initiatives.

Cooperation with the presidencies of the Council of the European Union in 2018, 2019 and 2020 is envisaged and could include direct support to Space related presidency events.

Type of Action: Public Procurement - Framework contracts and/or calls for tender

Indicative timetable: First, second, third and fourth quarters of 2018, 2019 and 2020

Indicative budget: EUR 1.30 million from the 2018 budget (indicative number of contracts: 5) and EUR 0.51 million from the 2019 budget (indicative number of contracts: 3) and EUR 5.40 million from the 2020 budget (Indicative number of contracts: 6)

11. Horizon 2020 project monitoring

This action will support the use of appointed independent experts by REA for the monitoring of running projects, where appropriate.

Type of Action: Expert Contracts

Indicative timetable: First quarter 2018, first quarter 2019, first quarter 2020

Indicative budget: EUR 1.16 million from the 2018 budget and EUR 0.96 million from the 2019 budget and EUR 1.28 million from the 2020 budget

12. Horizon 2020 tender evaluation, project monitoring and audits (EGNSS)

This action will support the use of appointed independent experts by the EC for EGNSS direct management and by GSA for the monitoring of running projects, where appropriate.

Type of Action: Expert Contracts

Indicative timetable: First quarter 2019, first quarter 2020

Indicative budget: EUR 0.50 million from the 2019 budget (this amount will be partially entrusted to the European GNSS Agency in addition to the budget entrusted to the Agency for the implementation of the Galileo Applications Call for Proposals) and EUR 0.50 million from the 2020 budget (this amount will be partially entrusted to the European GNSS Agency in addition to the budget entrusted to the Agency for the implementation of the Galileo Applications Call for Proposals)

13. Copernicus evolution – Research activities in support of a European operational monitoring support capacity for fossil CO₂ emissions⁶⁰

This action is intended as a continuation of the CO₂ Human Emissions (CHE) project, led by the European Centre for Medium-Range Weather Forecasts (ECMWF)⁶¹.

In line with Regulation EU 377/2014, which identifies ECMWF as one of the entities to be involved in the implementation of the Copernicus service component and article 190(1) (d), (e) and (f) of the Financial Regulation, this action shall be awarded to ECMWF, as the body responsible for the implementation of the Copernicus climate service, its high degree of specialisation and its administrative power, together with additional partners principally based on the CHE consortium.

The main objective is to perform R&D activities identified as a need in the CHE project and strongly recommended by the CO₂ monitoring Task Force⁶². These R&D activities will sustain the operational support capacity in a seamless and consistent way through all partners contributing to the CHE project.

International relationships and coordination are ensured by the CHE Advisory Board and technical Expert Group where experts associated with international institutions and non-European countries will continue to provide high level guidance and relevant recommendations.

The activities shall sustain the development of a European operational monitoring support capacity for fossil fuel CO₂ emissions. These activities should therefore address all components of the system, such as atmospheric transport models, re-analysis, data assimilation techniques, bottom-up estimation, in-situ networks and ancillary measurements needed to address the attribution of CO₂ emissions.

The activities shall in particular support an open standard integrated system test bed for the components above, which will be gradually replaced by pre-operational components as they become available. Such a test bed shall in particular help to understand expected end-to-end performances for different scenarios for space-borne and in-situ observations, different implementation options of the above components, as well as to reply to evolving policy-driven future questions. The main activities should address a series of scientific and critical system design issues identified by the CO₂ monitoring Task Force.

As it is already expected that the spatial resolution and the accuracy of the atmospheric transport models have to be significantly increased in order, for instance, to match the km

⁶⁰ This grant will be awarded without call for proposals in line with Article 190(1)(e) of the Rules of applications of Regulation (EU, Euratom) 966/2012, Regulation No 1268/2012 and Article 11(2) of the Rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)", Regulation (EU) No 1290/2013.

⁶¹ The CHE Coordination and Support Action is implemented under the Horizon 2020 grant agreement No 776186 with the objective to lay the foundation for the operational integration of all relevant European capacities and address some fundamental R&D issues. The CHE project consortium comprises 22 partners from 8 European countries..

⁶² http://edgar.jrc.ec.europa.eu/news_docs/Report_Copernicus_CO2_Monitoring_TaskForce_2017.pdf.

scale resolution of the CO₂ measurements from space, the Observing System Simulation Experiments have to be set-up to help in defining the in-situ component resulting from an optimised configuration given the future CO₂ satellite constellation.

Research activities are also required to better evaluate the contribution to fossil fuel emissions and thus address the attribution issue, as well as to strengthen the capacity for bottom-up estimation. This target will require the development of new measurement techniques and instruments to fill existing gaps. The overall performance of the system when reaching its full capability has to be assessed in particular with respect to the time and space requirements suggested by end users. By the same token, the potential and essential functionalities of a decision support system have to be established.

More generally, this action should support the design of an integrated support capacity, enabling European experts to collectively share their knowledge and join forces on the multiple fronts required to develop such a system with operational capabilities.

The activities should fulfil the technological and scientific needs for the integration of this European end-to-end operational capacity, in particular:

- Contribute to solving scientific issues that are critical to ensure a successful development of the operational system;
- Improve the performance and resolution of regional scale atmospheric transport models;
- Make a significant contribution to helping countries evaluate the effectiveness of their CO₂ emission reduction strategies such as those associated with the impact of the Nationally Determined Contributions;
- Support the optimal planning of networks of in-situ measurements in coordination with the WMO Integrated Global Observing System (WIGOS) programme, and contribute to develop and validate techniques enabling the quantification of fossil fuel CO₂ emissions;
- Identify the functionalities of a decision support system for monitoring anthropogenic emissions and address the expected capacities suggested by the CO₂ monitoring Task Force;
- Ensure the 'fit for purpose' of the entire system with regard to the expected capabilities.

This action contributes to the Horizon 2020 focus area on "Building a low-carbon, climate resilient future".

Legal entities:

The European Centre of Medium-Range Weather Forecasts (ECMWF), Shinfield Park, Reading, UK, together with additional partners principally based on its CHE consortium will be the direct beneficiaries for this funding, (<https://www.che-project.eu/partners>)

Type of Action: Grant to identified beneficiary - Coordination and support actions

Indicative timetable: Fourth quarter 2019

Indicative budget: EUR 9.00 million from the 2019 budget

14. In-orbit validation/demonstration – Mission design, integration and implementation⁶³

One of the main objectives of the Space strategy for Europe is to foster a globally competitive and innovative European space sector in particular by improving support to technological maturity, for sub-systems, equipment and technologies, including in-orbit demonstration and validation activities, to reduce time to market.

To ensure European non-dependence and competitiveness in technologies, there is a clear need for a regular, sustainable, cost-effective and responsive IOD/IOV service in Europe. Space flight heritage in real conditions and environment is often required to de-risk innovations such as new technologies, products, concepts, architectures, and operations techniques be they for unique or recurrent, institutional or commercial missions.

Although flight opportunities do exist, these are often difficult to find ad hoc at affordable cost and/or in the required timeframe, and at an acceptable risk for the main mission.

The main challenge of the overall IOD/IOV activity is to provide a regular and cost-effective solution for common flight ticket actions (management, spacecraft design and possible reuse for multiple mission, Assembly, integration and Tests, launch and operations) based on European solutions both for the spacecraft (i.e. platform and aggregate of experiments) and for the ground and launch services.

Concerning launch aspects, IOD/IOV shall support the European launcher exploitation policy, therefore relying on European manufactured launcher solutions.

The purpose of this action is to provide solutions for the mission analysis, planning, design, experiments accommodation and implementation and shall therefore comprise all the necessary tasks to prepare, provide and operate spacecraft(s), together with the related ground segment, which accommodates the pre-selected IOD/IOV experiments. It includes:

- System studies, at ground and space level, including the compatibility with the available launchers;
- Input to the launch mission analysis performed by the launch service provider;
- Selection, assembly, integration and testing of the spacecraft(s) and related ground segment;
- Management of interfaces with and between the different IOD/IOV experiments, between the satellite and the launcher and between the satellite and the ground segment;

⁶³ This action shall be complementary and coherent with actions 1 and 4. All three actions shall, therefore, be implemented by ESA under one single contribution agreement.

- Preparation of the spacecraft(s) for the flight;
- In-orbit testing and operations including the provision of experiments data.

Such an IOD/IOV service should be built on European solutions for the spacecraft, ground segment and launch system and shall only consider those experiments which have already reached a sufficient TRL to proceed as IOD/IOV candidates.

The IOD/IOV service shall be implemented through a competitive process managed by the European Space Agency as described in the technical guidance document⁶⁴. Accordingly, it shall only address the IOD/IOV actions presented in this guidance document, and shall include the necessary engineering reviews as well as a contingency management plan and associated resources (at least 20%)..

For proposals under this action:

- Participation of industry, in particular SMEs, is encouraged;
- Involvement of post-graduate scientists, engineers and researchers is also encouraged, for example through professional work experience or through fellowships/scholarships as applicable;
- Synergies with European Structural and Investment Funds⁶⁵ (ESIF) actions can be considered.

The expected impact of this action shall be to:

- Maximise IOD/IOV opportunities;
- Significant contribution to the reduction of time to market of the innovations subject of the IOD/IOV actions compared with the situation today;
- Support to setting up a regular cost-effective IOD/IOV service for European technologies;
- Support to European IOD/IOV solutions including space and associated ground segment;
- Aggregation of IOD/IOV demand for European launch services.

Implementation: Indirect management by the European Space Agency under contribution agreement⁶⁶

Type of Action: Contribution agreement with an implementing entity (indirect management)

⁶⁴ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

⁶⁵

http://ec.europa.eu/research/regions/pdf/publications/h2020_synergies_201406.pdf#view=fit&pagemode=none

⁶⁶ Since the contribution agreement is stipulated in the new EU Financial Regulation, the condition for its use shall be the effective entry into force of the latter.

Indicative timetable: First quarter of 2019 and first quarter of 2020 respectively

Indicative budget: EUR 38.00 million from the 2019 budget

15. Awareness raising activities on Space funding opportunities

Horizon Europe will bring new funding opportunities and conditions for the European Space arena. It is important that knowledge about this will be available from the start of the new Framework Programme since first calls will be published in late 2020 or in the beginning of 2021. National Contact Points (NCPs) are very well positioned and experienced in raising awareness in the space community all over Europe through information days including facilitating partner search and match making.

In order to complement the already planned activities of the network of Space NCPs, support is needed for the organisation of conferences, information events and partner search/match-making to launch the first Space calls of Horizon Europe with the aim of strengthening wider participation in the programme.

Activities may also support the preparation and dissemination of communication material and enable communication of EU Space activities.

Type of Action: Public Procurement - Framework contracts and/or calls for tender

Indicative timetable: Second and third quarter of 2020

Indicative budget: EUR 0.30 million from the 2020 budget (Indicative number of contracts: 2)

16. Studies on system definition of a Quantum Communication Infrastructure for Europe

The study will support the development of the EU Quantum Communication Infrastructure (QCI) initiative

The main objective is to perform the feasibility and the preliminary system definition (for both the Terrestrial and Space segments) of the QCI.

This activity should therefore address all components of the system and will notably provide a detailed roadmap for the development and deployment of the architecture with the key technologies and technology components required for the terrestrial and space segment, including R&D efforts. Particular attention will be paid to EU non-dependence for critical components and technologies, and sustainability of EU supply chains.

Type of Action: Public Procurement - Call for tender

Indicative timetable: Third and fourth quarters of 2020

Indicative budget: EUR 4.00 million from the 2020 budget (Indicative number of contracts:2. Additional co-financing of 4 million EURO from LEIT-ICT)

Budget⁶⁷

	Budget line(s)	2018 Budget (EUR million)	2019 Budget (EUR million)	2020 Budget (EUR million)
Calls				
H2020-SPACE-2018-2020		104.00	83.00	103.50
	<i>from 02.040201</i>	<i>104.00</i>	<i>83.00</i>	<i>103.50</i>
H2020-SPACE-EGNSS-2019-2020			20.00	21.00
	<i>from 02.040201</i>		<i>20.00</i>	<i>21.00</i>
Contribution from this part to call H2020-EIC-FTI-2018-2020 under Part 17 of the work programme		3.37	3.37	3.37
	<i>from 02.040201</i>	<i>3.37</i>	<i>3.37</i>	<i>3.37</i>
Other actions				
Contribution agreement with an implementing entity (indirect management)		45.00	38.00	
	<i>from 02.040201</i>	<i>45.00</i>	<i>38.00</i>	
Financial Instrument		6.00	7.00	7.00
	<i>from 02.040201</i>	<i>6.00</i>	<i>7.00</i>	<i>7.00</i>
Grant to Identified beneficiary		0.60	15.00	
	<i>from 02.040201</i>	<i>0.60</i>	<i>15.00</i>	
Specific Grant Agreement			4.90	65.70
	<i>from 02.040201</i>		<i>4.90</i>	<i>65.70</i>

⁶⁷ The budget figures given in this table are rounded to two decimal places. The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

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Public Procurement		1.30	3.51	11.70
	<i>from 02.040201</i>	<i>1.30</i>	<i>3.51</i>	<i>11.70</i>
Indirect Management by ESA		36.00	31.00	10.00
	<i>from 02.040201</i>	<i>36.00</i>	<i>31.00</i>	<i>10.00</i>
Expert Contracts		1.16	1.46	1.78
	<i>from 02.040201</i>	<i>1.16</i>	<i>1.46</i>	<i>1.78</i>
Contribution from this part to Prize under Part 17 of the work programme				5.00
	<i>from 02.040201</i>			<i>5.00</i>
Estimated total budget		197.43	207.24	229.05