

EN

Annex 8

Horizon 2020

Work Programme 2018-2020

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

Important notice on the Horizon 2020 Work Programme

This Work Programme covers 2018, 2019 and 2020. The parts that relate to 2019 and 2020 are provided at this stage on an indicative basis. Such Work Programme parts will be decided during 2018 and/or 2019.

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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 (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.

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 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 participant portal as well as on europa portal¹

Guidance Document	Call Topic
Copernicus evolution: guidance document for Horizon 2020 Work Programme 2018	LC-SPACE-02-EO-2018; LC-SPACE-03-EO-2018
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	SPACE-12-TEC-2018
In-orbit validation/demonstration: guidance document for Horizon 2020 Work Programme 2019-2020	SPACE-18-TEC-2019-2020

2020 call topics

This work programme contains detailed information on calls and other actions for the years 2018 and 2019. Topic titles and indicative budgets for the year 2020 are listed in the section "CALLS and OTHER ACTIONS for 2020".

Contribution to focus area(s)

Focus Area 'Digitising and transforming European industry and services' (DT): EUR 59.00 million

Focus Area 'Building a low-carbon, climate resilient future' (LC): EUR 82.00 million

Focus Area 'Boosting the effectiveness of the Security Union' (SU): EUR 94.60 million

¹ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

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.

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 early 2018. 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 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-2019-2020: Copernicus evolution – Research activities in support of cross-cutting applications between Copernicus services
- LC-SPACE-05-EO-2019: Copernicus evolution – Research activities in support to a European operational monitoring system for fossil CO₂ emissions
- DT-SPACE-06-EO-2019: International Cooperation Copernicus – Designing EO downstream applications with international partners
- LC-SPACE-14-TEC-2018-2019: Earth observation technologies

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 entered into force in 2014 and produces a wealth of data and information regarding the Earth sub-systems (land, atmosphere, oceans and inland waters) and cross-cutting processes (climate change, disaster management and security). Copernicus data and information are mainly made available on a free, open and full basis. This is expected to unleash unique market opportunities. It is important to foster market development, exploiting the added value of integration of Earth observation (EO) technologies (both satellite, airborne and ground based) other data from different sources and across different market segments through the development of applications, and encourage their insertion into the market.

For such applications and developments to succeed in the market, the product needs to be shaped according to user 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.

Synergies in the context of GEOSS need to be exploited where appropriate.

Scope: Proposals should address a wide variety of applications stemming from the use of Earth observation and its 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 should lead to greater value, opportunities and especially market uptake. As long as the Data and Information Access Services (DIAS)² are operational at the time of the publication of the call for proposals its facilities leveraging on the big data collection and processing should be part of the proposed application. Alternative cloud computing providers may be used in the case DIAS is not operational at the time of the publication of the call for proposals.

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 need to address the scalability and cost efficiency of the solution, demonstrating how it will work on a large region or even global scale.

Proposals should be innovative in at least one of these dimensions: market, product, process or business model.

Participation of industry, in particular SMEs, is encouraged.

² For the benefit of users, the Copernicus programme is setting-up several data and information access services (DIAS) to ensure that access and processing of Copernicus Sentinel data and service information are done in a state of the art computing environment. As a principle, the project shall use the DIAS instead of setting-up their own download and processing infrastructure. Where research projects need such services they shall receive access from the DIAS operator (for free or charged, depending on the nature of the service provided). In case the access is charged, the cost to use any DIAS for the purpose of the project shall be eligible.

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 Earth observation value added products and services with demonstrated commercial value and targeted client communities;
- Establish sustainable supply chains for innovative Earth observation value added products and services with demonstrated innovative technology;
- Demonstrate 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;
- Enhance European industry's potential to take advantage of market opportunities and establish leadership in the field, as well as boost business activity;
- Lead to new or improved products, processes or services on the market, which are capable of generating a significant turnover and creating new jobs.

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 via expert groups, studies and workshops will be provided³.

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

³ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

- 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 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).

Following the Copernicus Service Implementation and Copernicus Space Component Evolution Plan, the Commission has set up:

- A Polar Mission Experts Group, comprising key players involved in Earth monitoring in the Arctic and Polar regions. Snow covered areas are also considered in this process.
- An Agriculture Expert Group, involving the EC players of the Common Agricultural Policy.

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 by the Experts Group;
- 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 by the Experts Group 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 Copernicus programme Committee and User Forum.

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.

In late 2016, an expert group was convened to address 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. From the several improvement paths identified by experts, 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 via expert groups, studies and workshops is published together with this work programme⁴.

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:

- 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-2019-2020: 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

⁴ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

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, resilience of built environment, cultural heritage, coastal monitoring, urban planning, climate adaptation, biodiversity and eco-system preservation, exploration and mineral resources, and others. Copernicus DIAS⁵ facilities leveraging the big data collection and processing should be taken into account, in order to exploit the potential of data fusion to its maximum, especially in the case of huge data extent (i.e. long time series of multisensory data, which may bring additional value to cross-cutting new applications).

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 advised to consult information on the Copernicus programme in general at <http://copernicus.eu>, the evolution topics identified there, the guidance document provided⁶

⁵ For the benefit of users, the Copernicus programme is setting-up several data and information access services (DIAS) to ensure that access and processing of Copernicus Sentinel data and service information are done in a state of the art computing environment. As a principle, the project shall use the DIAS instead of setting-up their own download and processing infrastructure. Where research projects need such services they shall receive access from the DIAS operator (for free or charged, depending on the nature of the service provided). In case the access is charged, the cost to use any DIAS for the purpose of the project shall be eligible.

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

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 website⁷.

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.

Participation of industry, in particular SMEs, is encouraged.

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.

⁷ <http://www.copernicus.eu/main/data-access>

LC-SPACE-05-EO-2019: Copernicus evolution – Research activities in support to a European operational monitoring system for fossil CO₂ emissions

Specific Challenge: A recent expert report assessing the need and opportunity for an independent European capacity for CO₂ anthropogenic emissions has motivated an inter-institutional large scale activity to address the global monitoring of the fossil fuel emissions. The specific challenge is that while benefiting from advanced space infrastructures, there should be an operational capacity addressing a variety of scientific needs, such as reducing uncertainties on currently reported emission estimates, and policy issues related to the CO₂ anthropogenic emissions, and assessing the effectiveness of CO₂ emission reduction strategies should be developed. Following the Copernicus Space Component Evolution Plan, the Commission has set up a CO₂ monitoring task force involving various players and Copernicus partners, selected experts in atmospheric modelling, statistical emission inventories and data assimilation, with two work packages addressing separate but interconnected tasks. The first work package (Task A co-convened by ESA and the Commission) is dealing with the Space Component (a constellation of CO₂ oriented instruments), the second work package (Task B convened by the Commission) is addressing the end-to-end operational emission monitoring system, including thus inverse modelling, in-situ observation networks, and emission inventories. The overarching objective is to conduct the required R&D activities that will support this operational system.

Scope: Proposals shall support the development of a European operational monitoring system for fossil fuel CO₂ emissions and shall provide the appropriate and suitable support to activities identified as priorities by the CO₂ monitoring task force. These activities should therefore address all components of the system, e.g., atmospheric transport models, re-analysis, data assimilation techniques, bottom-up estimation, in-situ networks, ancillary measurements needed to address the attribution of CO₂ emissions.

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 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 measurements 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 Research and Innovation action should support the design of an integrated Fossil Fuel Data Assimilation System by European experts, enabling them to collectively share their knowledge and join their forces on the multiple fronts required to develop such a system with operational capabilities.

A technical guidance document⁸ will be published with this work programme providing clarification and information in line with an update analysis with respect to the evolution of Copernicus in this domain.

The Commission considers that proposals requesting a contribution from the EU of 9 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: Fulfil the technological and scientific needs for the integration of this European end-to-end operational system, in particular:

- Contribute to solving scientific issues that are critical to ensure a successful development of the operational system;
- Improve on the performance and resolutions of regional scale atmospheric transport models;
- Make a significant contribution helping countries in evaluating 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 discrimination from other sources – e.g. biomass burning.

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.

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

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

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.

It is encouraged to cooperate on data processing and applications using the Copernicus DIAS, 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.

Activities shall include joint cal/val activities or integration of local in-situ systems to enhance 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 website⁹.

For projects to be funded under this topic:

- Participation of partners from countries that have signed a Copernicus Cooperation Arrangement¹⁰ is required;
- Participation of industry, in particular SMEs, is encouraged;
- 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

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

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

¹⁰ See Copernicus.eu for list of countries concerned

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 programmes¹¹ 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.

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):

¹¹ Notably Horizon 2020, COSME, the European Structural Investment Funds.

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;
- 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 to 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, 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;
- 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.

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: Selected actions from the JTF List of Actions 2018-2020 shall be implemented sequentially in 2018 and in 2019 as follows.

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-2018/20-17 – 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 document¹², based on the JTF List of Actions 2018-2020, is published together with this work programme 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;

¹² <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

- 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.

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:

- 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-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/ISRU¹³ 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 programme¹⁴.

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
- 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-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

¹³ ISRU = In Situ Resource Utilisation.

¹⁴ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

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:

- **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 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.

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

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 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 ≥ 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.

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,

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

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 EO. Proposals should demonstrate significant improvements in such areas as miniaturisation, power reduction, efficiency, versatility, and/or increased functionality, and should demonstrate at 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 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:

- 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 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;

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>

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-off-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, standard dispensers) 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 the possible evolutions of the regulatory framework, 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 roadmaps at European level.

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-18-TEC-2019-2020: In-orbit validation/demonstration – Mission design, integration and implementation

Specific Challenge: 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 are 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 activities 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 specific challenge of this activity is to provide solutions for the mission analysis, planning, design, experiments accommodation and implementation.

Scope: In order to bring these innovations to maturity and market applicability, the activities shall 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. The activities include:

- 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;

- 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 available for the spacecraft, ground segment and launch system.

The proposals will only consider those experiments which have already reached a sufficient TRL to proceed as IOD/IOV candidates.

The IOD/IOV actions are selected according to the process described in the technical guidance document published together with this work programme²⁰. Accordingly, proposals shall only address the IOD/IOV actions presented in this guidance document and shall include the necessary engineering reviews, a contingency management plan and associated resources (roughly 10%) in line with the provisions of that document.

Selected projects resulting from SPACE-18-TEC-2019-2020 shall interface with ESA and the European Launch Service Provider in the context of their engineering support and launch services activities respectively on the basis of a collaboration agreement.

Participation of industry, in particular SMEs, is encouraged.

The Commission considers that proposals requesting a contribution from the EU in the range of EUR 20 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:

- 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 European IOD/IOV solutions including space and associated ground segment;
- Aggregation of IOD/IOV demand for European launch services.

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.

²⁰ <http://ec.europa.eu/growth/sectors/space/research/horizon-2020>

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.

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 or the impact of space weather. 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-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 ESA²¹ 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.

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.

Conditions for the Call - Space 2018-2020

Opening date(s), deadline(s), indicative budget(s):²²

²¹ <http://swe.ssa.esa.int/>

²² 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.

Horizon 2020 - Work Programme 2018-2020
Leadership in Enabling and Industrial Technologies - Space

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			
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-2019-2020 (RIA)		8.00		
LC-SPACE-05-EO-2019 (RIA)		9.00		
LC-SPACE-14-TEC-2018-2019 (RIA)		8.00		

All deadlines are at 17.00.00 Brussels local time.

The deadline(s) in 2019 and 2020 are indicative and subject to separate financing decisions for 2019 and 2020.

The budget amounts for the 2018 budget are subject to the availability of the appropriations provided for in the draft budget for 2018 after the adoption of the budget 2018 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

The budget amounts for the 2019 and 2020 budget are indicative and will be subject to separate financing decisions to cover the amounts to be allocated for 2019 and for 2020.

Horizon 2020 - Work Programme 2018-2020
Leadership in Enabling and Industrial Technologies - Space

SPACE-10-TEC-2018-2020 (RIA)		12.00		
SPACE-13-TEC-2019 (RIA)		10.00		
SPACE-17-TEC-2019 (RIA)		9.00		
SPACE-18-TEC-2019-2020 (RIA)		20.00		
SU-SPACE-22-SEC-2019 (RIA)		9.00		
Opening: To be defined				
Focus area topic(s) for 2020			43.00	To be defined
Overall indicative budget	104.00	101.00	43.00	

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:

LC-SPACE-02-EO-2018	A maximum of one proposal per sub-topic shall be selected for funding.
SPACE-10-TEC-2018-2020	<p>Applicants can only select actions listed in group A for the call opening in 2017.</p> <p>Applicants can only select actions listed in group B for the call opening in 2018.</p> <p>Applicants can only select actions listed in group C for the call opening in 2020.</p> <p>A maximum of one proposal per action shall be selected for funding.</p>
SPACE-12-TEC-2018	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.

	A maximum of one proposal per sub-topic shall be selected for funding..
SPACE-13-TEC-2019	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. A maximum of two projects for transversal technologies shall be selected for funding.
SPACE-16-TEC-2018, SPACE-17-TEC-2019	A maximum of two proposals per sub-topic shall be selected for funding.
DT-SPACE-06-EO-2019	Participation of partners from countries that have signed a Copernicus Cooperation Arrangement is required ²³ .

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 Participant 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.
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

²³ <http://Copernicus.eu/>

	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-18-TEC-2019-2020	Grants awarded under this topic will be complementary to each other as well as complementary to the ESA engineering support action and the "in-orbit demonstration/validation – launch services" action of the work programme. In order to ensure a smooth and successful implementation, 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.

Consortium agreement:

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, LC-SPACE-02-EO-2018, LC-SPACE-03-EO-2018, LC-SPACE-04-EO-2019-2020, LC-SPACE-05-EO-2019, LC-SPACE-14-TEC-2018-2019, 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-18-TEC-2019-2020, SPACE-20-SCI-2018, SU-SPACE-22-SEC-2019	Members of consortium are required to conclude a consortium agreement, in principle prior to the signature of the grant agreement.
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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

To facilitate access to opportunities for applicants the following list includes dedicated 'Applications in Satellite Navigation – Galileo' activities in related calls and topics from other calls of H2020, in addition to those in this call:

LEIT-ICT

- ICT-28-2018: Future Hyper-connected Sociality
- DT-ICT-08-2019: Agricultural digital integration platforms

Societal challenge 1 – Health

- SC1-BHC-13-2019: Mining big data for early detection of infectious disease threats driven by climate change and other factors
- SC1-DTH-03-2018: Adaptive smart working and living environments supporting active and healthy ageing
- SC1-DTH-05-2019: Large scale implementation of digital innovation for health and care in an ageing society

Societal challenge 2 – Energy

- LC-SC3-ES-6-2020: Research on advanced tools and technological development

Societal challenge 4 - Transport:

- MG-2-9-2019: Integrated multimodal, low-emission freight transport systems and logistics(Inco Flagship)
- LC-MG-1-2-2018: Sustainable multi-modal inter-urban transport, regional mobility and spatial planning
- MG-2-6-2019: Moving freight by Water: Sustainable Infrastructure and Innovative Vessels
- MG-2-8-2019: Innovative applications of drones for safety in transport
- MG-3-2-2018: The Autonomous Ship
- DT-ART-01-2018: Testing, validation and certification procedures for highly automated driving functions under various traffic scenarios based on pilot test data
- DT-ART-04-2019: Developing and testing shared, connected and cooperative automated vehicle fleets in urban areas for the mobility of all
- DT-ART-02-2018: Support for networking activities and impact assessment for road automation

Moreover, Galileo activities are supported via the Fundamental Elements part of the EGNSS programme.²⁴

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

²⁴ https://www.gsa.europa.eu/sites/default/files/229046_-_galileo_exploitation_grant_plan_2017_for_publication.pdf

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.

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;
- High precision and authentication services that will be provided by Galileo, i.e. in the frame of the Commercial Service and in the frame of the Open Service authentication (OS NMA).

Actions should deliver new innovative applications, with commercial impact and a clear market uptake perspective. 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.

In projects to be funded under this topic participation of industry, in particular SMEs, is encouraged.

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.
- Commercialisation of the products and services developed. Proposals should include a including a business plan.

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 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.

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; 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.

In projects to be funded under this topic participation of industry, in particular SMEs, is encouraged.

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.
- Leveraging 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.

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 transactions²⁵ 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 high precision service in the frame of the future commercial service are contributing to enabling EGNSS innovative solutions, including in challenging environments.

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.
- 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;

²⁵ Cf. also Article 50 of Directive 2014/65/EU on Markets in Financial Instruments.

- High precision and authentication services that will be provided by Galileo, i.e. in the frame of the commercial service;
- 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. 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.

In projects to be funded under this topic participation of industry, in particular SMEs, is encouraged.

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:

- Development of 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.
- 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.
- The expected impact of innovative GNSS applications in agriculture is to improve the productivity and decrease the negative environmental impact.
- Timing and synchronisation applications should contribute to cope with emerging network synchronisation needs in terms of accuracy and robustness, while improving 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.

Conditions for the Call - EGNSS market uptake 2019-2020

Opening date(s), deadline(s), indicative budget(s):²⁶

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: To be defined			
Focus area topic(s) for 2020		20.00	To be defined
Overall indicative budget	20.00	20.00	

Indicative timetable for evaluation and grant agreement signature:

For single stage procedure:

²⁶ 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 deadline(s) in 2019 and 2020 are indicative and subject to separate financing decisions for 2019 and 2020.
The budget amounts for the 2019 and 2020 budget are indicative and will be subject to separate financing decisions to cover the amounts to be allocated for 2019 and for 2020.

- 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.

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 Participant 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).

DRAFT

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.

DRAFT

Other actions (2018-2020)

1. ESA engineering support²⁷

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 provide project and technical management support of projects resulting by the topic "SPACE-18-TEC-2019-2020: 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 with the launch service provider.

Legal entities:

The European Space Agency, 8-10 rue Mario Nikis 75738 Paris Cedex 15 France

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

Indicative timetable: Second quarter of 2018 and 2020 respectively

Indicative budget: EUR 4.00 million from the 2018 budget and EUR 2.00 million from the 2020 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

²⁷ 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.

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 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 Clusters²⁸

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

²⁸ 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.

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.

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 projects²⁹.
- 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 two consortia of the EPIC and PERASPERA projects

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 services

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.

²⁹See Article 6 of Guidelines for SRC's,

<https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/compet-03-2014.html>

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 topic SPACE-18-TEC-2019-2020 (standard scheme);
- 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 SPACE-18-TEC-2019-2020 shall interface with the 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 and with a view to optimising available European planned launch solutions. The result will be a dedicated work order to the launch service provider for each project. The work order will be implemented 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 2018 and 2020³⁰. 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, complementarity with available launch slots and related initiatives by Member States, ESA and other stakeholders shall be sought.

Legal entity: Arianespace

Type of Action: Public Procurement - Direct negotiation with Arianespace

³⁰ 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).

Indicative timetable: First quarter of 2018 and first quarter of 2019 respectively

Indicative budget: EUR 9.00 million from the 2018 budget and EUR 10.00 million from the 2019 budget and EUR 20.00 million from the 2020 budget

5. Space surveillance and tracking (SST)

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)³¹.

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 support to SST under Horizon 2020 and other Union funding programmes should be entrusted to the above Consortium³².

This activity consists in analysing, assessing and undertaking the necessary research, development and innovation activities with the specific aim 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; and (2) 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.

The activity should lead to a higher number of connected SST assets, allowing for improved quality and performance of SST in the future. 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.

³¹ OJ L 158 of 27 May 2014, p. 227–234

³² 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).

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 evaluation.

The activity will contribute to achieving the objectives set out in Annex 1 to the Commission Implementing Decision³³ on a coordination plan for the SST support framework and the procedure for participation of Member States³⁴.

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.

Impact will be assessed on the basis of the indicators and reporting obligations foreseen in the above Commission Implementing Decision.

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

Type of Action: Grant to identified beneficiary³⁵.

Legal entities:

The identified beneficiary 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 and the EU SATCEN.

Type of Action: Grant to identified beneficiary - Operating Grant

Indicative timetable: Fourth quarter 2018, fourth quarter 2019 and fourth quarter 2020 respectively

Indicative budget: EUR 1.80 million from the 2018 budget and EUR 1.90 million from the 2019 budget and EUR 1.90 million from the 2020 budget

6. Improving the Performances of the 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. Whereas existing assets were developed according to the needs of each

³³ COM(2016)8482 of 19.12.2016

³⁴ http://ec.europa.eu/growth/sectors/space/security_en

³⁵ In conjunction with the respective cumulative budget from Copernicus and EGNSS

Member State, activities shall aim at improving the SST performance at Union level while underpinning a coordinated and integrated Union SST capability.

This activity will support the upgrade and development of assets, in particular radars and telescopes, operated by Member States participating in the SST Support Framework in line with the overall Union SST architecture development roadmap. 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.

This activity will lead to an enhanced performance of the Union SST sensors. 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, such as the detection of smaller debris size. The integration of upgraded and developed sensors should be implemented in accordance with the needs for complementarity and optimisation of the SST architecture, as outlined in the EU SST architecture development roadmap.

The activity will contribute to achieving the objectives set out in Annex 1 to the Commission Implementing Decision³⁶ on a coordination plan for the SST support framework and the procedure for participation of Member States³⁷.

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 evaluation.

Impact will be assessed on the basis of the indicators and reporting obligations foreseen in the above Commission Implementing Decision.

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 support to SST under Horizon 2020 and other Union funding programmes should be entrusted to the above Consortium³⁸. 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.

³⁶ COM(2016) 8482 of 19.12.2016

³⁷ http://ec.europa.eu/growth/sectors/space/security_en

³⁸ 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).

The Union contribution for this activity complements the cumulative national investment of the Member States participating in the SST support framework and is largely exceeded by the latter.

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

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.

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 and the EU SATCEN.

Type of Action: Specific Grant Agreement

Indicative timetable: Fourth quarter 2018, fourth quarter 2019 and fourth quarter 2020 respectively

Indicative budget: EUR 15.00 million from the 2018 budget and EUR 20.00 million from the 2019 budget and EUR 30.00 million from the 2020 budget

7. 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 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

8. 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

9. 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)

10. Cooperation among NCPs³⁹

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 on the gender dimension of Research and Innovation, and twinning schemes. Special attention will be given to enhance the competence of NCPs, including helping less experienced NCPs rapidly acquire the know-how accumulated in other countries.

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:

³⁹ 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.

The consortium implementing the current COSMOS2020 grant modified following a request for expression of interest.

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

Indicative timetable: First quarter 2018

Indicative budget: EUR 0.60 million from the 2018 budget

11. Studies & Communication

Activities shall support the preparation of communication material, dissemination of material, or conduct public procurement activities to enable communication of Horizon 2020 Space activities, and for the organisation of events (conferences, workshops or seminars) related to the implementation of the European Space Policy, European R&D research agendas related to Horizon 2020.

Support may be given to the organisation of conferences and information events to strengthen wider participation in the programme (including that of third countries), and to disseminate results of European research in the Space sector. Cooperation with the presidencies of the Council of the European Union in 2018 and 2019 is envisaged.

Furthermore, procurement will be necessary for actions such as studies, preparation of roadmaps to underpin planning for Horizon 2020, or actions to evaluate the outcomes of R&D actions.

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.

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 1.50 million from the 2018 budget(indicative number of contracts: W) and EUR 0.50 million from the 2019 budget(indicative number of contracts: Z) and EUR 1.00 million from the 2020 budget(indicative number of contracts: Y)

12. 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

13. 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)

CALLS and OTHER ACTIONS for 2020

Multiannual call topics are described in the chapters "Call-Space" and "Call-EGNSS" also for the 2020 topics. For single year 2020 topics only topic title and budgets are given at this stage.

"Other actions" are multi-annual and thus fully described in the chapter "Other actions 2018-2020"

Call - Space 2020

H2020-LEIT-Space-2018-2020-continued

Earth observation

DT-SPACE-01-EO-2018-2020: Copernicus market uptake [**EUR 9.00 million**]

LC-SPACE-04-EO-2019-2020: Copernicus evolution – Research activities in support of cross-cutting applications between Copernicus services [**EUR 8.00 million**]

LC-SPACE-24-EO-2020: Copernicus evolution - Mission exploitation concepts [**EUR 8.00 million**]

DT-SPACE-25-EO-2020: Copernicus big data algorithm factory [**EUR 10.00 million**]

Space business, entrepreneurship, outreach and education

DT-SPACE-26-BIZ-2020: Space hubs (support to start-ups) [**EUR 2.00 million**]

Space technologies, science and exploration

SPACE-10-TEC-2018-2020: Technologies for European non-dependence and competitiveness [**EUR 12.00 million**]

SPACE-18-TEC-2019-2020: In-orbit validation/demonstration – Mission design, integration and implementation [**EUR 18.00 million**]

SPACE-27-TEC-2020: SRC - Space robotics technologies [**EUR 9.00 million**]

SPACE-28-TEC-2020: SRC - In space electrical propulsion and station keeping [**EUR 24.00 million**]

SPACE-29-TEC-2020: Satellite communication technologies [**EUR 9.00 million**]

SPACE-30-SCI-2020: Scientific data exploitation [**EUR 9.00 million**]

Secure and safe space environment

SU-SPACE-21-SEC-2020: Exploring concepts for space traffic management [**EUR 2.00 million**]

SU-SPACE-23-SEC-2020: Near Earth objects **[EUR 4.00 million]**

Call - EGNSS market uptake 2020

H2020-SPACE-EGNSS-2019-2020-continued

LC-SPACE-EGNSS-1-2019-2020: EGNSS applications fostering green, safe and smart mobility **[EUR 10.00 million]**

DT-SPACE-EGNSS-2-2019-2020: EGNSS applications fostering digitisation **[EUR 5.00 million]**

SU-SPACE-EGNSS-3-2019-2020: EGNSS applications fostering societal resilience and protecting the environment **[EUR 5.00 million]**

Other actions (2020)

These "other actions" for 2020 are described in detail under *Other actions 2018-2020*

1. ESA Engineering Support
2. InnovFin Space Equity Pilot (ISEP)
4. In-orbit demonstration/validation – launch services
5. Space surveillance and tracking (SST)
6. Improving the Performances of the SST at European Level
7. Galileo Evolution, Mission and Service related R&D activities
8. EGNOS, Mission and Service related R&D activities
9. GNSS evolution, infrastructure-related R&D activities
11. Studies & Communication
12. Horizon 2020 project monitoring
13. Horizon 2020 project monitoring and audits (EGNSS)

Budget⁴⁰

	Budget line(s)	2018 Budget (EUR million)	2019 Budget (EUR million)	2020 Budget (EUR million)
Calls				
H2020-SPACE-2018-2020		104.00	101.00	43.00
	<i>from 02.040201</i>	<i>104.00</i>	<i>101.00</i>	<i>43.00</i>
H2020-SPACE-EGNSS- 2019-2020			20.00	20.00
	<i>from 02.040201</i>		<i>20.00</i>	<i>20.00</i>
H2020-LEIT-Space-2018- 2020-continued				81.00
	<i>from 02.040201</i>			<i>81.00</i>
H2020-SPACE-EGNSS- 2019-2020-continued				
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				
Grant to Identified beneficiary		6.40	7.90	3.90
	<i>from 02.040201</i>	<i>6.40</i>	<i>7.90</i>	<i>3.90</i>
Financial Instrument		6.00	7.00	7.00
	<i>from</i>	<i>6.00</i>	<i>7.00</i>	<i>7.00</i>

⁴⁰ The budget figures given in this table are rounded to two decimal places.

The budget amounts for the 2018 budget are subject to the availability of the appropriations provided for in the draft budget for 2018 after the adoption of the budget 2018 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

The budget amounts for the 2019 and 2020 budget are indicative and will be subject to separate financing decisions to cover the amounts to be allocated for 2019 and for 2020.

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	02.040201			
Public Procurement		10.50	13.50	23.00
	from 02.040201	10.50	13.50	23.00
Specific Grant Agreement		15.00	20.00	30.00
	from 02.040201	15.00	20.00	30.00
Indirect Management by ESA		36.00	31.00	10.00
	from 02.040201	36.00	31.00	10.00
Expert Contracts		1.16	1.46	1.78
	from 02.040201	1.16	1.46	1.78
Contribution from this part to Prize under Part 17 of the work programme				5.00
	from 02.040201			5.00
Estimated total budget		182.43	205.23	228.05