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REQUEST FOR INFORMATION

Services for Human Space Exploration - Meeting ESA's future Research and Astronaut Mission Objectives in Low Earth Orbit and beyond

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1 INTRODUCTION

All major space players exercise their essential sovereign capability and soft power through human space exploration enabled by domestic human space transportation systems. Space exploration encompasses a variety of constituent elements while directly contributing to generate knowledge, innovation, industrial productivity and new markets.

Today, the space sector worldwide is undergoing a transition phase with structural changes leading to an increased prominence of commercial activities, new technologies and end-customer services. Such commercial activity is likely to significantly expand with a growing diversification of the use of space. It is crucial in this context that Europe is not left behind in seizing those opportunities in terms of services, economic growth and innovation. Indeed, the rapidly changing global context sees expanding space-enabled markets with the emergence of a commercial Low Earth Orbit economy (including post-International Space Station services), expected to extend also into cis-lunar space. Cargo and human space transportation are essential capabilities to access this new economic sphere.

In the context of the ESA Agenda 2025, the ESA Director General has set up an independent High-Level Advisory Group on ‘Accelerating the Use of Space in Europe’ to assess the economic, societal, and political role of space in an evolving global context and against emerging challenges. The High-Level Advisory Group provides advice on directions and actions for ESA to realise ambitious goals, together with other stakeholders, serving the future of Europe and its citizens (see RD1).

In its final report delivered in October 2021, the High-Level Advisory Group advised the Director General to further investigate the technical, political, programmatic, and economic relevance of developing a European human space transportation solution in light of recent developments observed in the global context (see RD2). On 19 November 2021, in the Matosinhos Manifesto, ESA’s Intermediate Ministerial Meeting in Portugal has unanimously adopted this advice. The resolution recommends ESA to investigate a so-called human space exploration ‘inspirator’ (see RD3).

As part of such an investigation, ESA is launching three individual but interlinked preparatory activities, covering the period 2028-2040:

1. Request For Information (RFI) on “Services for Human Space Exploration - Meeting ESA’s future Research and Astronaut Mission Objectives in Low Earth Orbit and beyond” (ESA-HRE-XI-RFI-0001)

Within the frame of the European “Terra Nova 2030+ Strategy Roadmap” for space exploration (see RD4), this RFI invites respondents to submit information on the interest of the private sector for delivering ESA’s Low Earth Orbit service requirements, including research accommodation, crew habitation as well as European cargo and human space transportation capabilities; and for how this could be provided within the wider context of global humans in LEO business.



2. Invitation To Tender (ITT) on “European Human Space Transportation Services” (see RD5)

Focusing on European end-to-end human space transportation service concepts and technology roadmaps while also proposing innovative approaches for procurement.

3. Invitation To Tender (ITT) on “Socio-Economic Elements of European Human Space Transportation” (see RD6)

Assessing the socio-economic benefits of European human space transportation autonomy in the global context, with a focus on economic considerations.

Together, the results of the three preparatory activities will be used to support political, strategic and programmatic decision making and in particular to inform the preparation of related study proposals to be submitted at the occasion of the ESA Council at ministerial level to be held in November 2022 (CM22). Development decisions would likely only be taken in 2025.

1.1 Scope of this RFI

The European Space Agency (ESA) is considering to procure end-to-end services for meeting its future objectives in Low-Earth Orbit (LEO) related to science, technology demonstrations, and astronaut missions.

This Request for Information (RFI) is soliciting information on the commercial interest of the private sector for delivering ESA’s LEO service requirements for the end of this decade, including research accommodation, crew habitation, as well as European cargo and human space transportation capabilities.

The responses to this RFI will inform pathways for ESA commercial service procurements in the frame of future periods of the Agency’s European Space Exploration Envelope Programme (E3P) (see RD7, RD8, RD9 and RD10), as well as for potential European cargo and human space transportation capabilities (systems and services) in the frame of ESA’s space transportation programmes (RD11).

ESA is interested in understanding the currently available or planned capabilities in related service segments, as described in **Section 2**. The availability of these commercial services are assumed to overlap with the lifetime of the International Space Station (ISS), which is currently envisaged until 2030 by the ISS International Partners. Accordingly, related first services should be available from the end of this decade, to ensure continuity in the European LEO presence.



ESA is preparing its future LEO activities in the frame of the “SciHab” (Science and Habitation) concept, proposed as Europe’s future keystone element in LEO. SciHab is under consideration as part of the Agency’s overall ‘Terra Nova 2030+ Strategy Roadmap’ (see RD4) to meet Europe’s long-term LEO utilisation needs.

The SciHab concept (see RD12) is an orbital human-tended platform capability consisting of:

1. core services (covering basic science, habitation and transportation functions);
2. potential modular strategic elements/services that could optionally be added at later stages (e.g. robotics, external platforms);
3. elements needed to enable commercial services not required by ESA (e.g. commercial research; in-space manufacturing; space tourism).

This RFI is requesting information related specifically to the SciHab core services (1 above), including the necessary cargo and human space transportation capabilities and their economic viability, considering global markets, and technical development needs and commercial competition. Options could include European human and cargo transportation system(s).

Respondents are free to provide additional information on potential modular strategic elements and services (2) and additional commercial services for non-ESA users (3) in case it is considered relevant within the scope of their response.

The evolution towards human transportation beyond LEO, including cis-lunar destinations, may also be addressed (see RD13).

Importantly, respondents are invited to non-restrictively propose the technical and procurement solutions for delivering service capabilities to ESA. Both existing and planned LEO infrastructures, facilities, and space transportation systems may be exploited, as long as they are compliant with ESA’s overall constraints (see **Section 3**).

1.2 Target Audience

This RFI is open to responses from consortia led by private sector¹ entities based in ESA Member States. It is assumed that ESA shall only buy services directly from European industry. In case participation of non-European partners in international industry-to-industry partnerships is envisaged (and especially encouraged for the LEO infrastructure elements),

¹ The private sector is understood as the part of the economy that is not state controlled, and is run by individuals and companies for profit. The private sector encompasses all for-profit businesses that are not owned or operated by the government.



this could allow, for instance, the bartering on a non-exchange of funds basis of some services which are needed to meet ESA's requirements which are provided by non-European economic operators.

1.3 Disclaimer

All information requested and provided in the frame of this RFI will be used for information and planning purposes only and is not part of an ESA procurement process. This RFI does not bind ESA to any present or future procurements actions nor does it create any rights for respondents in relation to any present or future ESA procurements.

1.4 Data Protection

ESA will use any personal data included in the responses to this RFI (e.g. names and contact details) exclusively for contacting the respondents in case it becomes necessary in relation to their submission. ESA will not disclose those personal data to third parties without prior agreement of the party that had submitted their response, as per ESA's Personal Data Protection Policy (RD14).

Regarding **intellectual property rights**, ESA will not release any information provided in the responses beyond the appointed members of the **ESA RFI Panel** and its Management in the Directorate of Human and Robotic Exploration (HRE), the Directorate of Space Transportation (STS), and the Directorate of Commercialisation, Industry & Procurement (CIP). ESA does not expect the responses to contain elements that are subject to non-disclosure obligations, protected by intellectual property rights, or resulting in limitations for ESA's use in the frame of the internal panel evaluation.

1.5 Reference Documents

The following documents may contain relevant information to prepare the submission:

- RD1. ESA Agenda 2025, <https://vision.esa.int/>
- RD2. High-Level Advisory Group on 'Accelerating the Use of Space in Europe', Final Report, October 2021, [https://esamultimedia.esa.int/docs/corporate/Accelerating the use of space in Europe.pdf](https://esamultimedia.esa.int/docs/corporate/Accelerating_the_use_of_space_in_Europe.pdf)
- RD3. ESA's Intermediate Ministerial Meeting in Portugal, Matosinhos Manifesto, https://esamultimedia.esa.int/docs/corporate/ESA_C_2021_176_EN.pdf
- RD4. Terrae Novae 2030+ Strategy Roadmap, November 2021, ESA-star Publications
- RD5. ESA Invitation To Tender (ITT) on "European Human Space Transportation Services", AO/1-11063/21/KBP, <https://esastar-publication.sso.esa.int/ESATenderActions/details/22679> (registered users only)
- RD6. ESA Invitation To Tender on "Socio-Economic Elements of European Human Space Transportation", ESA-star Publications (registered users only)
- RD7. ESA's European Space Exploration Envelope Programme (E3P) - Overview, <http://youbenefit.spaceflight.esa.int/we-explore/>



- RD8. ESA European Exploration Envelope Programme (E3P) - Brochure, https://esamultimedia.esa.int/docs/corporate/Space19+flyers_HRE_LR.pdf
- RD9. ESA Business in Space Growth Network (BSGN), <https://bsgn.esa.int>
- RD10. ESA “Science in Space Environment” (SciSpacE), https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Research/
- RD11. ESA’s Space Transportation Programmes overview, https://www.esa.int/Enabling_Support/Space_Transportation
- RD12. The SciHab concept - Lighthouse for Europe’s Post-ISS engagement in Low Earth Orbit, November 2021, ESA-star Publications
- RD13. Gateway Partnership, News Article, October 2020, <https://www.nasa.gov/press-release/nasa-european-space-agency-formalize-artemis-gateway-partnership>
- RD14. ESA Personal Data Protection Framework, https://www.esa.int/About_Us/Law_at_ESA/Highlights_of_ESA_rules_and_regulations
- RD15. ESA Call for Commercial Partnerships for Space Exploration, November 2021 (permanently open), <https://ideas.esa.int/servlet/hype/IMT?documentTableId=45087658249839084&userAction=Browse&templateName=&documentId=07d2fff3d67ab66a82798783439ceba4>

2 SERVICES DESCRIPTION

This RFI has been issued to support the identification of potential service providers and implementation approaches for the end-to-end LEO services described below. In their response to this RFI, industry is invited to describe how it would offer these services to ESA on a commercial basis, either in part or by covering the entire set of identified services.

The high-level ESA needs for LEO commercial services for the end of this decade are provided in the **Annex 2**, including requirements related to the human space transportation systems. These needs are expected to be met over a notional period of 10 years, as per ESA's overall 'Terra Nova 2030+ Strategy Roadmap' in LEO (see RD4). Industry is also encouraged to describe how its approach might be affected or improved if the operational period was assumed to be more or less than 10 years.

In the frame of future service procurements, ESA may decide to involve multiple suppliers or other measures in order to foster competition and lower the risk for the Agency.

Respondents to this RFI are also requested to provide information on the ESA support mechanism that should be put in place to enable the establishment of these commercial services. This information shall refer to, for example, the type of contractual framework or level of upfront commitment required from the Agency. Related information on ESA's mechanism for developing and implementing public-private partnerships can be found in RD15.

Detailed information on ESA's LEO utilisation activities in the frame of its "Science in Space Environment" activity (SciSpacE) can be found in RD10.

Industry is invited to describe how it would address one or more of the following core services.

2.1 Research accommodation

Generic intra- and extravehicular science and research volume that can accommodate experiment hardware of various sizes and purposes, including the provision of resources (e.g. power, data, cooling, gases, venting, vacuum, stowage).

2.2 Habitation

Basic habitation functions to sustain the long-term presence of humans (environmental control and life support, communications, crew quarters, galley, toilet, hygiene space, cardio-pulmonary and strength exercise devices, on-board medical support facility, stowage).

2.3 Space transportation

Space transportation capability to LEO and return, for both cargo and humans.



- The cargo transportation includes conditioned transportation (plus sample stowage hardware, e.g. freezers) and services related to ground logistics, launch site preparations, payload and launcher integration, and retrieval.
- The human space transportation service is to be understood as end-to-end, including mission integration and logistical cargo transport (e.g. consumables, clothing, food, waste handling).

Please note that a specific Invitation to Tender (ITT) related to human space transportation service concepts and technology roadmaps will be issued in parallel to this RFI (see RD5).

2.4 Crew time

End-to-end availability of a trained ESA astronaut in-orbit for executing LEO activities. The crew time considers the utilisation time only, excluding systems maintenance, resting and exercise periods.

2.5 Crew training (facility-level)

Crew training encompasses services related to the specific training of ESA astronauts at facility/payload-level, including mission-specific training, training for transport vehicles and mission hardware, and crew procedure development. These services are to be provided under the assumption that ESA will maintain an institutional Astronaut Corps. Therefore, the selection process, medical and crew support, basic and generic mission training shall remain ESA tasks.

2.6 Utilisation Management

Services related to the overall LEO utilisation activities, including payload integration, accommodation, operations preparation, utilisation planning and manifesting, and outfitting in terms of (research) facilities and station support equipment.

2.7 System-level operations

End-to-end operations in support of ESA astronauts on-orbit, including ground segment provision, communications (tele-command and telemetry), on-board resource provision and management (power, data, stowage etc), station monitoring, orbit control, flight plan management, crew safety, crew health monitoring and environmental data to ESA medical support, environmental monitoring and control, ground personnel training, and pre/in/post-flight ops support (hardware, data collection, return and dissemination to Principal Investigators (PIs)). Provided service capabilities shall adhere to human spaceflight standards, especially with respect to safety and off-nominal response capabilities (e.g. Caution & Warning system, maintainability, repairs, EVA and external robotics serviceability).



2.8 Facility-level operations

Services related to real-time facility and payload operations, including functions such as preparation of activity procedures, operations requirements, plans, and processes, development and verification of qualification tests, and ground personnel training². Facility-level operations also include the capability to allow scientists to remote-operate their own payloads (“Payload Sandboxing”).

2.9 Facility/payload development

Services related to the end-to-end development cycle for LEO facilities and payloads, including requirements definition, design, manufacture, testing, safety and verification. Provision of main interface to principal investigators (PIs) for all ESA utilisation activities.

² Equivalent to or better than current USOC (User Support and Operation Centre) activities

3 CONSTRAINTS

Within the scope of this RFI, the following constraints apply in view of ESA pursuing its programmatic goals.

The Agency's consideration for future procurements of LEO commercial services is to create economic activity in Europe commensurate with the overall ESA investment, while ensuring research opportunities to its user community. While ESA will act as an enabling customer, it is assumed that the overall industrial activity realised by the service provider will be the result of parallel commercial engagements with other parties. This means that ESA shall be only one among multiple customers. Industry is therefore invited to discuss its business models and assumptions for securing and supporting non-ESA users.

The respondents to this RFI may intend to use both existing and to be developed future, preferably European, LEO infrastructures, facilities, and transportation systems for delivering their service capabilities to ESA. All these assets may be used by the service provider also for other commercial purposes, with the provision that ESA's requirements and values are not impacted, including its Ethical Standards³.

In the context of the overall 'Terra Nova 2030+ Strategy Roadmap' in LEO (see RD4), ESA currently does not envisage the development of an institutional European infrastructure to deliver the end-to-end SciHab concept (see RD12, e.g. LEO research module(s), crew capsule, human space transportation system). However, in view of ensuring continuity in the European LEO presence beyond the lifetime of the ISS, especially the human space transportation capability is an integral part of such end-to-end service. Related capabilities could be developed within the frame of novel competitive procurement schemes and public-private funding approaches. This RFI therefore also invites information on potential European human space transportation services and related aspects such as development, economic viability, global market framework and competition.

More detailed information on related constraints and ESA's LEO requirements are to be specified by the Agency in due course and in any case after the evaluation of the initial response to this RFI.

³ The scope of this RFI explicitly excludes activities promoting, or being related to, alcohol, tobacco, religion, politics, intolerance, violence, firearms, pornography, obscenity, gambling or illegal drugs. In addition, involved services and related infrastructure should not be in conflict with the Space Agreements, policy, and legal aspects or any law or treaty, e.g. launch of missiles, use of military hardware in force. Some links to find space policies, agreements, treaties, etc. are given below:

- www.oosa.unvienna.org/oosa/SpaceLaw/outerspt.html
- www.unoosa.org/oosa/COPUOS/copusos.html
- [www.esa.int/About_Us/ECSL - European Centre for Space Law](http://www.esa.int/About_Us/ECSL_-_European_Centre_for_Space_Law)



4 SUBMISSION

Responses to this RFI should be submitted **on ESA-star Publications**.

In a first step, respondents shall notify to ESA their interest to respond to this RFI, together with an executive summary of maximum 5 pages and in PDF format. When preparing the executive summary, respondents may be guided by the questionnaire provided in **Annex 1**.

The **deadline for submitting the executive summary** is on 28 January 2022.

Secondly, full responses shall be submitted by completing the **Word template** (questionnaire) provided on the website. The Word template contains the same fields as shown in **Annex 1**.

The **deadline for submitting the full response** is on 31 March 2022.

ESA may contact individual respondents to request further information on their submission.



5 NEXT STEPS

ESA will review the submissions in order to inform future approaches for commercial service procurement in support of its future human LEO and beyond activities. ESA intends to procure these services on a competitive basis. The information received in response to this RFI will be used as a input for preparing potential next steps from 2022 onwards.

This RFI is requesting information related to the SciHab core services and human and cargo space transportation capabilities. However, respondents are free to provide additional information on modular strategic elements related to the overall SciHab concept (see RD12, e.g. robotics, external platforms, a test bed for long-duration Mars transit habitation, and other capabilities including services for third party commercial users) in case it is considered relevant.

5.1 RFI Workshop

Following the release of this RFI, ESA is preparing a dedicated workshop for respondents to gather more information and to discuss ESA requirements and constraints, while offering a networking opportunity to create consortia. More information on this workshop will be published on ESA-star Publications and on the ESA Business in Space Growth Network (BSGN) website in due course (see RD9).



6 ANNEXES

- Annex 1 - Online submission template
- Annex 2 - ESA Service Requirements



Annex 1 – Online submission template

The submission template below will be available as Word document on the ESA-star Publications website for this RFI.

Section 1: Background information

1.1 Submission title:			
1.2 Document reference number: <i>(provided by responding entity)</i>			
1.3 Lead company: <i>(company name, address, country, web-site, contact point name, telephone and e-mail)</i>			
1.4 Company background: <i>(year of creation, industrial sector, size, turnover, number of employees).</i>		1.5 Are you familiar with ESA and the European Exploration Envelope Programme (E3P)? <i>(Yes/No)</i>	
1.6 Are you applying as a consortium? <i>(Yes/No)</i> Who are the other entities? <i>(company name, country, website)</i>			
1.7 Have you (or your consortium members) worked with ESA before? <i>(Yes/No/Partial + comments. If yes, please briefly mention on which activities and projects)</i>			
1.8 How did you become aware of this RFI? <i>(e. g. via ESA Web site, specific event, business network, National Delegation, brochure, Twitter, Facebook, from previous activities)</i>			

Section 2: Level of commercial service and added value

2.1 What is the level of commercial service you envisage? <i>(please specify each type of service you are responding to, as per Section 0 of the RFI)</i>
2.2 How will the service be established and provided by you (or by your consortium)? <i>(please outline the development steps and other relevant information towards realising the service)</i>
2.3 How does the envisaged level of service fit within your current business activities and your mid-/long-term strategy?



2.4 What is innovative in your commercial approach? What are your unique selling points to ESA?
2.5 Which LEO asset/ infrastructure do you intend to provide and why? (both existing or future) <i>(e.g. existing facilities on-board the ISS, future human LEO infrastructure, free flyers, space transportation systems, crew capsules, cargo vehicles, other related assets/infrastructure required for service delivery)</i>
2.6 Do you envisage a European capability for the human space transportation service? <i>(Please comment on aspects like development, economic viability, global market and competition)</i>
2.7 Does your team (company / consortium) have the right skills and experience to deliver the services you envisage? <i>(Yes/No/Partial + comments. Please indicate which skills/expertise you possess/miss with respect to the consortium members involved, and per type of service covered)</i>
2.8 Would you like to mention also additional services related to the modular strategic elements of the SciHab concept? <i>(e.g. robotics, external platforms, other capabilities for third party commercial users)</i>

Section 3: Market position and expected impact

3.1 Are you already providing an operational service? What is your current market position and the level of competition?
3.2 Will there be customers other than ESA? <i>(If Yes, please provide an estimation of the ratio ESA to non-ESA service provision, with justification)</i>
3.3 Who are your current customers? <i>(Please indicate customer types, industry/market segments, and geographical location)</i>
3.4 How much would you charge for your service? <i>(please indicate your pricing policy per type of service)</i>
3.5 Which high-level socio-economic benefits do you expect to deliver and over which timeframe?



(Outline the expected benefits for you and your consortium partners if applicable, e.g. jobs created, revenues generated, scale up plans)

Section 4: Implementation with ESA

4.1 What are the next steps you suggest to enable implementation in partnership with ESA?

4.2 Which of the services you provide would require additional ESA support?

(Please specify ESA support required, e.g. access to ground-based laboratories and test facilities, access to ESA hardware or equipment, provision of mission operations capabilities, safety review, flight certification, crew medical support etc)

4.3 Which ESA support mechanism should be put in place to enable the establishment of these commercial services?

(Please refer to aspects such as type of contractual framework and level of commitment required)

4.4 What are the major risks (technical / business / commercial) to your service provision? What are your mitigation plans?

Annex 2 - ESA Service Requirements

This annex defines the high-level ESA requirements for each LEO commercial service, as introduced in **Section 2** of this RFI.

It is to be understood that:

- the requirements identified here can be challenged by the respondents;
- it is acceptable that only a subset of these requirements are addressed;
- alternative options can also be presented by the responders.

A2.1 Research Accommodation

Requirement ID	Requirement
RFI-ACC-010	The research accommodation service shall provide rack space in LEO for facility accommodation. Rack spaces shall include e.g. a glove box facility and animal research facilities.
RFI-ACC-020	The research accommodation service shall provide 10-15 modular versatile rack spaces per year, to the equivalent of at least 20 m ³ total volume.
RFI-ACC-030	In addition to requirement RFI-ACC-020, 3-4 rack spaces shall be dedicated for science payload stowage, to the equivalent of at least 5 m ³ total volume.
RFI-ACC-040	The research accommodation service shall provide on-board resources to racks, including power, data band-width, data on-board storage, vacuum access, venting, gas supplies, heat rejection, microgravity quality.
RFI-ACC-050	The microgravity quality shall be equivalent to or better than the ISS and data on the microgravity environment shall be made available to ESA for the entire duration of its utilisation by ESA on-orbit.
RFI-ACC-060	The research accommodation service shall provide at least 1.5 m ³ on-board stowage for hardware (system equipment, spare parts etc)
RFI-ACC-070	The research accommodation service shall provide at least 1.5 m ³ on-board temperature conditioned stowage for science samples (e.g. freezers, configurable range: -80C to +40C).

RFI-ACC-080	The research accommodation service shall provide at least one Earth observational window for science applications, which may be used independently from a recreational window (i.e. no interference between science and recreational purposes, even when used in parallel).
RFI-ACC-090	The research accommodation service shall provide at least one Earth observational window with a large field of view for long lens crew photography, education and recreation, which may be used independently from the science application window (i.e. no interference between science and recreational purposes, even when used in parallel). Allowing access for at least two crew members at the same time.
RFI-ACC-100	The research accommodation service shall provide mounting interfaces for external platforms (allowing nadir & zenith observations), external robotics, and an airlock for scientific and technological experiments, deployment of cubesats etc.
RFI-ACC-110	The research accommodation service shall provide at least two docking ports that are available for visiting vehicles.
RFI-ACC-120	All external and internal payload and expansion interfaces shall be open standard, allowing for expansion and usage by other entities.
RFI-ACC-130	The end-to-end research accommodation service may be provided by using more than one on-orbit infrastructure, which may also be used by third party users for their own purposes.

A2.2 Habitation

Requirement ID	Requirement
RFI-HAB-010	The habitation service shall include basic habitation functions to sustain the long-term presence of humans in LEO (to include but not limited to environmental control and life support, communications, crew quarters, galley, toilet, hygiene space, cardiopulmonary and strength exercise devices, on-board medical support facility, stowage).
RFI-HAB-020	The habitation service shall be capable of supporting a minimum of 2 ESA astronauts simultaneously for durations of at least six months.

	Industry is invited to discuss the implications of enabling mission durations of one year or more.
RFI-HAB-030	The habitation service shall provide atmosphere conditions comparable to a standard atmosphere (in terms of pressure and O ₂ /N ₂ composition). Trace gases, CO ₂ and other constituents shall be equal or lower than those on the ISS, unless otherwise justified.
RFI-HAB-040	The end-to-end habitation service may be provided by using more than a single on-orbit infrastructure and may be simultaneously occupied and used by any number of other spaceflight participants or operational astronauts.
RFI-HAB-050	The potential service provider is invited to discuss whether the habitation element(s) could be used or adapted for use in a long-term Mars transit habitation simulation.

A2.3 *Space transportation*

Requirement ID	Requirement
RFI-TRA-010	Space transportation services to LEO and return are required for either or both cargo and humans (i.e. crew/ astronauts): Services offered could also include functions related to ground segment, operations, communications, and launch site provision. The implications of a possible incremental evolution to cis-lunar transportation shall be considered and discussed. Transportation services employing different vehicles to enable all or part of the required services may be proposed for consideration.
RFI-TRA-020	The human space transportation service shall be end-to-end, including the provision of the crew vehicle, launcher, supporting ground infrastructure, and the functions of mission integration and logistical cargo transport (e.g. consumables, clothing, food, waste).
RFI-TRA-030	The human space transportation service shall enable at least 2 ESA crew members per year to travel to and from LEO, transported individually or simultaneously, and any number of non-ESA crew.
RFI-TRA-040	The human space transportation service shall enable with adequate safety and security at least two six-month missions per year. Potential service providers are invited to discuss the implications of enabling missions of at least one year.

RFI-TRA-050	The cargo space transportation service shall include the functions of ground logistics, launch site preparations, access to laboratory facilities, payload and launcher integration, payload retrieval after landing, and return to the PIs (principal investigators).
RFI-TRA-060	The upload cargo space transportation service shall be provided for a minimum of 500 kg per year for ESA utilisation activities, and any amount for non-ESA users.
RFI-TRA-070	The download cargo space transportation service shall be provided for a at least 200 kg per year for ESA utilisation activities, plus any amount for non-ESA users.
RFI-TRA-80	The cargo space transportation service shall provide continuous powered sites for experimental containers during upload and download.
RFI-TRA-90	The feasibility of the cargo space transportation service allowing late load up to 3 hours before launch and early access to retrieval of conditioned samples (within 3 hours of landing), including access to laboratory facilities shall be discussed.
RFI-TRA-100	The design, construction and operations of the end-to-end human space transportation service, including the crew vehicle, launcher, and supporting ground infrastructure, shall be subject to an ESA safety certification, launch readiness reviews and flight readiness reviews for missions involving ESA crew or missions in the vicinity of ESA assets. For all missions involving ESA institutional assets/infrastructure, an Agency review is required for the use of these assets.
RFI-TRA-110	The human transportation service shall be compatible with international standards on docking interfaces (IDSS).
RFI-TRA-120	The human space transportation service shall allow for the possibility to have at least two crew transport vehicles docked to the on-orbit LEO infrastructure simultaneously, to allow for a direct on-orbit handover between two crews.
RFI-TRA-130	The human space transportation service shall be economically viable and environmentally sustainable throughout its life cycle.

A2.4 Crew time

Requirement ID	Requirement
RFI-CRE-010	The crew time service shall be the end-to-end availability of a trained ESA astronaut in-orbit for executing LEO activities.
RFI-CRE-020	The crew time shall include the utilisation time only, and exclude systems maintenance activities, resting and exercise periods.
RFI-CRE-030	The crew time shall be compatible with the assumed mission durations.

A2.5 Crew training (facility-level)

Requirement ID	Requirement
RFI-CRT-010	<p>The crew training service shall include mission-specific training, including training for transport vehicles, specific mission hardware and on-board facilities.</p> <p><i>Note: crew training services shall be provided under the assumption that ESA will maintain an institutional Astronaut Corps. Therefore the selection process, medical and crew support, basic and generic mission training, and exercise & countermeasures support shall remain ESA tasks.</i></p>
RFI-CRT-020	The crew training service shall support operating 10-15 rack-level facilities per year.
RFI-CRT-030	The crew training service may be provided under the assumption that ESA offers access to its European Astronaut Centre (EAC) and related facilities.

A2.6 Utilisation management

Requirement ID	Requirement
RFI-UTIL-010	The utilisation management service shall include payload integration, accommodation, operations preparation, utilisation planning and manifesting, and outfitting in terms of (research) facilities and station support equipment.

RFI-UTIL-020	The utilisation management service shall support 10-15 rack spaces and accommodated facilities/payloads.
RFI-UTIL-030	The utilisation management service shall support a fast turnaround and implementation of experiments, including fast access to LEO orbit (aiming at < 1 year from first customer contact to on-orbit installation).

A2.7 *System-level operations*

Requirement ID	Requirement
RFI-SOPS-010	<p>The system-level operations service shall be the end-to-end operations in support of ESA astronauts on-orbit, including:</p> <ul style="list-style-type: none"> • ground segment provision, • communications (tele-command and telemetry), • on-board resource provision and management (power, data, stowage etc), • station monitoring and orbit control, • flight plan management, • crew safety, • crew health monitoring and environmental data to ESA medical support, • environmental monitoring and control, • ground personnel training, and • pre/in/post-flight ops support (hardware, data collection, return and dissemination to PIs).
RFI-SOPS-020	The system-level operations service shall sustain at least 2 ESA crew members simultaneously for durations of at least six months. The implications of mission durations of at least one year shall be discussed.
RFI-SOPS-030	The system-level operations service shall be provided during the end-to-end ESA crewed missions, as specified under requirement RFI-HAB-020.
RFI-SOPS-040	The system-level operations service shall also be provided during times when ESA payloads are running unattended or operated during periods with no ESA crew member in orbit.

RFI-SOPS-050	The system-level operations service shall adhere to a minimum of ISS-level human spaceflight standards with respect to safety, human factors, and off-nominal response capabilities (e.g. Caution & Warning system, maintainability, repairs, EVA and external robotics serviceability). E.g., ECSS or SSP 50005 / 51721.
RFI-SOPS-060	For the on-orbit part of the astronaut mission, the risk for a Loss of Crew (LOC) shall be less than 1 in 500 for a 180 day mission.
RFI-SOPS-070	For the on-orbit part of the astronaut mission, the risk for a Loss of Mission (LOM) shall be less than 1 in 100 for a 180 day mission.

A2.8 Facility-level operations

Requirement ID	Requirement
RFI-FOPS-010	<p>The facility-level operations service shall include functions such as:</p> <ul style="list-style-type: none"> • preparation of activity procedures, operations requirements, plans, and processes, • development and verification of qualification tests, and • ground personnel training.
RFI-FOPS-020	The facility-level operations service shall include the capability to allow scientists to remote-operate their own payloads (sometimes known as “Payload Sandboxing”).
RFI-FOPS-030	The facility-level operations service shall be provided during the end-to-end ESA crewed missions (see RFI-SOPS-030), including times when ESA payloads are running unattended, or operated during periods with no ESA crew member in orbit (see RFI-SOPS-040).
RFI-FOPS-040	The facility-level operations service shall include an internal robotics system that allows for 1) autonomous operations of a subset of payloads and limited maintenance tasks during un-crewed periods, as well as for 2) task support for astronauts during crewed periods. This system shall be mobile within the LEO accommodation volume, and it shall be able to operate remotely controlled as well as fully autonomously for a period of at least 1 day at a time.
RFI-FOPS-050	The end-to-end facility-level operations service may be provided by using more than one on-orbit infrastructure.

A2.9 Facility/payload development

Requirement ID	Requirement
RFI-DEV-010	The facility/payload development service shall provide the end-to-end development cycle for LEO facilities and payloads.
RFI-DEV-020	The facility/payload development service shall include requirements definition, design, manufacture, testing, safety and verification and include provision of the main interface to Principal Investigators (PIs) for all ESA utilisation activities.
RFI-DEV-030	<p>The facility/payload development service shall enable at least 15 facilities/ payloads per year.</p> <p><i>Note: see RD10 for detailed information on SciSpaceE (ESA's "Science in the Space Environment").</i></p>