



Annual Report 2015





International Space Exploration Coordination Group – ISECG

ISECG was established in response to the “The Global Exploration Strategy: The Framework for Coordination” (GES) developed by 14 space agencies and released in May 2007. This GES Framework Document articulated a shared vision of coordinated human and robotic space exploration focused on solar system destinations where humans may one day live and work.

The purpose of ISECG is to provide a forum to discuss interests, objectives and plans in space exploration and to support promotion of interest and engagement in space exploration activities throughout society. The work of ISECG agencies results in documents, papers, findings and recommendations that are critical in informing individual agency decision making.

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1 Executive Summary

2015 was a productive and successful year for ISECG. One milestone with respect to its membership was the accession of the United Arab Emirates Space Agency (UAE SA), demonstrating the continued interest of agencies to engage in focused international strategic exchange and coordination.

A major focus in 2015 was continuation of activities articulated in the Global Exploration Roadmap ([GER](#)), an update of which is planned for publication in the first half of 2017. The work is driven by shared international exploration goals for cislunar, lunar and future Mars exploration activities. In the process of advancing the common roadmap, ISECG agencies are undertaking joint work on specific topics of high priority for the implementation of future mission scenarios. Along those lines several major efforts were pursued in 2015, one of which aims at a better understanding of lunar volatiles and their use as resources, for which a dedicated website and related virtual workshops were started. Agencies also discussed options for a reference lunar surface access transportation architecture, as well as analyzed strategies for a scenario of missions to the lunar South Pole. Continuing their commitment to seek appropriate opportunities to coordinate technology investments, ISECG agencies started two study activities in order to assess technology gaps in discipline areas that traditionally had not been worked at an international level. ISECG assembled teams of technical experts from participating agencies in the areas of dust mitigation and Liquid Oxygen (LOX)/Methane propulsion. ISECG agencies also supported the review of robotic missions, which may be incorporated in the GER human exploration architecture.

Furthermore, ISECG space agencies are preparing a Science White Paper, taking account of the importance of scientific objectives for pursuing synergetic human and robotic international space exploration. A dedicated Science Advisory Group is interacting with the global scientific community in order to identify the scientific return and scientific opportunities enabled by early human exploration missions.

Another activity of ISECG member agencies in 2015 was an exchange on lessons learned and best practices in communicating and delivering benefits resulting from investments in space exploration. Discussions focused on the topics of technology transfer, health and medicine, and sustainable resource management (related to e.g. life support systems), all of which were of common interest to participating agencies. Additionally, an international meeting specifically on the subject of technology transfer was organised by ESA.

2 ISECG Highlights, Achievements and Special Projects in 2015

New ISECG Member:

United Arab Emirates Space Agency (UAE Space Agency)



In October, the United Arab Emirates Space Agency (UAE Space Agency) joined ISECG as its newest member. The UAE established its space agency in 2014, marking the beginning of a new era in space for the country. In 2015 and 2016 the Space Agency is drafting the policy, strategy and law and regulations for the UAE space sector.

In 2014, the UAE Space Agency had announced a scientific orbiter mission to Mars, the UAE Mars Mission. The project is a major undertaking for the new space agency with an envisaged launch date in 2020.

The accession of the UAE Space Agency demonstrates the interest of agencies to engage in focused international strategic exchange and coordination, and to build new strategic partnerships for advancing the implementation of the Global Exploration Strategy.

More information about the UAE Space Agency can be found at

<http://www.space.gov.ae/>.

Understanding Lunar Volatiles and Collaborating in Analogue Missions

The ground work for exploration partnerships also comprises joint work on specific topics that are instrumental when building a common roadmap. In 2015 a major new effort was initiated to gain a better understanding of lunar volatiles and their use as resources.

Space agencies recognise that it is important to characterise resources available at exploration destinations in order to assess their possible role in human space exploration and, where possible, to develop and validate technologies and systems that extract, process, and utilise these resources for the exploration missions of the future. The Exploration Roadmap Working Group (ERWG) created a dedicated website for the global space community to share information and facilitate ongoing discussions about the exploration and potential utilisation of lunar polar resources. The website is accessible via the ISECG home page www.globalspaceexploration.org. To promote community consensus, a series of virtual workshops were held, the first of which covered the topic of available lunar datasets. Amongst others, community consensus may help realize early robotic missions to fill the strategic knowledge gaps necessary to inform the planning for subsequent human missions.

In the area of analogue simulation activities, interested agencies pursued various measures in order to facilitate awareness and foster collaboration opportunities to prepare for human space exploration as described in the Global Exploration Roadmap (GER). Several agencies participated in the NASA Extreme Environment Mission Operations (NEEMO) 20 mission in July 2015. NEEMO 20 featured an integrated evaluation of tools and operational protocols, e.g. for micro- and partial gravity Extravehicular Activity (EVA) techniques and hardware and the evaluation of crew self-scheduling tools and techniques. The CSA, in partnership with an academic team led by the University of Western Ontario, carried out a robotic field deployment in Utah during November 2015. This activity simulated aspects of a robotic Mars Sample Return (MSR) caching mission. A second deployment with international participation to continue the MSR simulation is planned for late 2016.

Concept for an International Human Lunar Architecture

Building on past work, ISECG space agencies have continued to develop a possible international architecture for a series of human missions to the lunar surface beginning in the late 2020's as described in the GER, including understanding the value of robotic precursor activities.

The human lunar architecture concept was advanced within the framework of three complementary activities, conducted by the International Architecture Working Group (IAWG). The first activity included defining options for a reference lunar surface access transportation architecture. The Group adopted common ground rules and assumptions and then conducted internal agency trades on the various parameters in order to meet established GER objectives. A reference lunar lander design of a two-stage, four crew member capable spacecraft was selected for further study because it best met the stated objectives. The second activity focused on determining a staging location that met objectives for multiple exploration goals including cislunar, lunar and future Mars exploration activities. The result of these studies led to the consensus selection of the Earth-moon near-rectilinear orbit (NRO) as a prime location for an evolvable Deep Space Habitat (eDSH). Third, potential strategies for a series of five missions of 28 days each to the lunar surface were articulated and were assessed to a science-driven set of proposed landing sites on the lunar South Pole.

Furthermore, the IAWG also supported the review effort of the 'Human-Enhanced Robotic Architecture and Capabilities for Lunar Exploration and Science' (HERACLES) lunar sample return concept, which has been proposed by ESA, and is continuing to explore options for incorporating robotic missions within the GER human exploration architecture. 2016 activities will continue where 2015 left off by conducting new trades on lunar surface elements and systems for incorporation into the next GER to be published in 2017.

Towards an ISECG Science White Paper

Throughout 2015 ISECG has continued its interaction with the global scientific community with the goal to develop a Science White Paper (SWP) that identifies and discusses the scientific opportunities enabled by early human exploration missions.

One important milestone has been a dedicated townhall meeting associated to the European Lunar Symposium 2015 on 15 May in Frascati (Italy), where many representatives from agencies and the international science community discussed the scope, planning and preliminary contents of the Science White Paper in several sessions. The ISECG Science Working Group and its Science Advisory Group, which organized the event together with the Solar System Exploration Research Virtual Institute (SSERVI), sought feedback from the scientists on the current outline of the GER mission themes and the scientific opportunities they entail, including potential requirements stemming from maximizing scientific return. Many comments, contributions and recommendations were received from the participating scientists and were subsequently incorporated into the first draft of the Science White Paper. The document will be further developed and finalized in 2016.

Topical Gap Assessment: Dust Mitigation, LOX/Methane Propulsion

Based on an analysis of critical technologies needs, ISECG has started to evaluate topic discipline areas that traditionally had not been worked at an international level to-date. The first topic discipline is 'Dust Mitigation' and the second one is 'LOX/Methane Propulsion'. For

both topic disciplines the ISECG Technology Working Group (TWG) also involved subject matter experts from participating agencies.

The goal and objectives were to identify technology gaps related to, but not limited by, the current GER mission scenario and to reveal opportunities for international coordination and cooperation for closing identified gaps. Thus, the focus of the analysis was on cislunar and lunar mission themes as well as long-lead items for human Mars exploration and those that could also be applicable in the lunar environment.

With respect to dust mitigation viable technology solutions have been found, but those still need further maturation before supporting missions. It was noted that no single technology today provides a complete solution to the challenges, but rather a suite of technologies will be required to address the challenges of dust mitigation.

LOX/Methane Propulsion still bears open questions related to this propulsion technology and its role as an enabler for future exploration with in-situ (Mars) propellant production, improved performance, and fluid commonality.

It was noted that analysis of additional topics regarding other critical technology needs may be beneficial to agency decision making with respect to the development of exploration technologies and identification of collaboration opportunities.

Lessons Learned and Best Practices in Communicating and Delivering Benefits from Space Exploration

In the frame of the ISECG Strategic Communications Working Group (SCWG) agencies exchanged lessons learned and best practices in communicating and delivering benefits resulting from investments in space exploration. In 2015, the discussion focused on three topics of common interest to participating agencies: technology transfer, health and medicine, and sustainable resource management (e.g. life support systems). On request of participating agencies' technology transfer experts, an international Space Technology Transfer Exchange Meeting was hosted by ESA's Technology Transfer Programme Office at ESA-ESTEC on 22-23 September 2015.

3 Outlook for 2016/2017

Exploration Roadmap Working Group (ERWG)

The Exploration Roadmap Working Group will focus on preparing an update of the Global Exploration Roadmap (GER), targeting publication for the first half of 2017. As part of this GER preparation, space agencies are discussing considerations such as the importance of the ISS and next steps in LEO and cislunar space. In addition, space agencies will continue the virtual workshops on the topic of polar volatiles. The intention is to post summary reports of each telecon and continue community engagement in order to strengthen the effort to obtain funding for instruments and missions. Participation among partner agencies in future analogue missions that are announced or discussed during respective telecons or by other communication channels will be facilitated.

International Architecture Working Group (IAWG)

The IAWG continues to develop a reference lunar surface architecture for the primary GER mission scenario in response to strategic guidance from the ERWG.

- Goal for 2017 is to establish international humans to lunar surface architecture to inform potential international investment strategies and collaboration opportunities

Science Working Group (SWG)

The SWG aims at finalizing the Science White Paper (SWP) in 2016.

- Joint workshop co-organized by the COSPAR Panel for Exploration and ISECG agencies planned for 10-11 February 2016 in Paris to discuss the draft SWP and to consolidate its contents and key messages
- SWP publication targeted for fall 2016

Strategic Communications Working Group (SCWG)

The SCWG will continue to implement and coordinate communication of the ISECG mandate, its products and activities. Major activities will comprise the following:

- Issuing ISECG webnews as appropriate;
- Preparation of the ISECG Annual Report 2016;
- Providing support of ISECG publications (e.g. the Global Exploration Roadmap and the Science White Paper), ISECG outreach activities (e.g. co-hosted workshops) and ISECG contributions to international conferences;
- Continuation of the dedicated activity on lessons learned and best practices in communicating benefits from space exploration. In particular, the scope of the work in 2016 will include an exchange on robotics and to sharing information on socio-economic impact assessment studies related to investments in human spaceflight.

Technology Working Group (TWG)

The TWG aims in 2016 to continue to advocate coordination and collaboration in technology development efforts of individual ISECG space agencies in support of the GER. In particular, the TWG will continue to perform a technology gap identification & closure analysis with focus on critical technologies and investment gap analysis in relation to the implementation of the GER and identify opportunities to collaborative technology development.

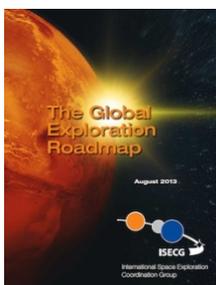
Annex I

Publications

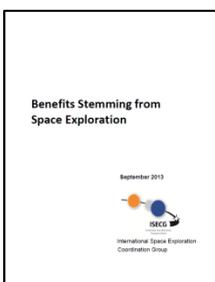
ISECG Webnews 2015

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| <u>Space Policy Journal Special Issue about the “Global Exploration Roadmap”</u> | March |
| <u>Introducing ESA’s Space Exploration Strategy</u> | May |
| <u>ESA experimental spaceplane completes research flight extending Europe’s capability for space exploration</u> | June |
| <u>“Hello” from Space – Lander Philae is awake</u> | July |
| <u>International Space Agencies Meet to Advance Space Exploration</u> | October |
| <u>ISECG Space Agencies Welcome UAE Space Agency as New Member</u> | October |
| <u>Space voyage to an asteroid: Hayabusa2 Earth Swing-by</u> | December |

Major ISECG Documents



[The Global Exploration Roadmap \(GER\), August 2013](#)



[Benefits Stemming from Space Exploration](#)



[ISECG Terms of Reference](#)

More ISECG documents and published papers can be found at [ISECG Publications](#).

Annex II

ISECG Members and Working Groups

Members



[Agenzia Spaziale Italiana](#) (ASI), Italy



[Canadian Space Agency](#) (CSA), Canada



[Centre National d'Etudes Spatiales](#) (CNES), France



[China National Space Administration](#) (CNSA), China



[Commonwealth Scientific and Industrial Research Organisation](#) (CSIRO), Australia



[Deutsches Zentrum für Luft- und Raumfahrt](#) (DLR), Germany



[European Space Agency](#) (ESA)



[Indian Space Research Organisation](#) (ISRO), India



[Japan Aerospace Exploration Agency](#) (JAXA), Japan



[Korea Aerospace Research Institute](#) (KARI), Republic of Korea



[National Aeronautics and Space Administration](#) (NASA), United States of America



[Russian Federal Space Agency](#) (Roscosmos), Russia



[State Space Agency of Ukraine](#) (SSAU), Ukraine



[United Arab Emirates Space Agency](#) (UAE Space Agency), United Arab Emirates



[United Kingdom Space Agency](#) (UKSA), United Kingdom

Working Groups

Exploration Roadmap Working Group (ERWG)

The Exploration Roadmap Working Group leads the human spaceflight roadmapping effort which is intended to advance a common roadmap, and common framework to promote partnerships in realising exploration missions. A summary of their work is communicated in regular updates of the Global Exploration Roadmap (GER).

International Architecture Working Group (IAWG)

The International Architecture Working Group leads multilateral reference architecture work, develops shared requirements, identifies critical functions and technologies and shares innovative architectural concepts. The IAWG is currently building concepts to augment the GER mission scenario, focusing specifically on characterizing human missions to the lunar surface based on robust international partner contributions.

Strategic Communications Working Group (SCWG)

The objectives of the SCWG are to provide a clear, consistent and coordinated communication of the ISECG mandate, its products and activities, to support the development of ISECG products, as well as to support the exchange amongst agencies on stakeholder engagement activities. Major activities of the SCWG include the development of ISECG webnews, the preparation of the ISECG Annual Report and the facilitation of topical exchanges amongst agencies.

The SCWG is fostering an exchange on lessons learned and best practices among ISECG agencies in communicating and delivering benefits resulting from investments in space exploration.

Science Working Group (SWG)

The Science Working Group coordinates with science communities on exploration planning and activities as required for the generation of ISECG products. It currently focusses on advancing the development of a Science White Paper for the articulation of science opportunities in the GER in conjunction with the science communities.

Technology Working Group (TWG)

The goal of the Technology Working Group is to identify and raise awareness on critical technology gaps related to the GER, and to advocate coordination and collaboration in technology development efforts of individual ISECG space agencies in support of the GER. The strategic nature of technology investments and the desire of space agencies to focus investments to maximize their contribution potential while enabling meaningful and achievable opportunities for all participating agencies must hereby be recognized.

Annex III

ISECG at a Glance: Scope and Background

ISECG, the International Space Exploration Coordination Group serves as the forum where space agencies work together on means of strengthening individual exploration programs, facilitating collaborations and advancing the Global Exploration Strategy (GES) through the coordination of participating agencies' mutual efforts in space exploration. ISECG also supports promoting interest and engagement in space exploration activities throughout society.

The **scope of ISECG** is broad and strategic. Its activities are based on the following **principles**:

- Open and inclusive
 - ISECG receives inputs from all interested agencies that invest in and perform space exploration activities.
 - ISECG provides for consultations among all agencies with a vested interest in space exploration.
- Flexible and evolutionary
 - Existing consultation and coordination mechanisms are taken into account.
- Effective
 - ISECG workshops and products provide value to individual participating agencies.
- Of mutual interest
 - ISECG activities benefit all participants and respect national prerogatives.
 - ISECG activities allow for optional participation based on the level of interest.
 - ISECG participants focus on developing non-binding products - findings, recommendations and other outputs as necessary – based on consensus.

Background

In May 2007, 14 space agencies¹ jointly released "[The Global Exploration Strategy: The Framework for Coordination](#)". It describes a shared vision of coordinated human and robotic space exploration focused on solar system destinations where humans may one day live and work.

The GES identifies a common set of **exploration themes and benefits**:

- New knowledge in science and technology
- A sustained presence – extending human frontiers
- Economic expansion
- A global partnership
- Inspiration and education

One of the many Framework document findings was the need to facilitate information exchange among individual agencies regarding their interests, plans and activities in space exploration. Therefore, the GES called for a voluntary, non-binding coordination mechanism among interested space agencies. This call led to the establishment of **ISECG** by the participating agencies including the formulation of [Terms of Reference](#) (ToR).

¹ In alphabetical order: ASI (Italy), CNES (France), CNSA (China), CSA (Canada), CSIRO (Australia), DLR (Germany), ESA (European Space Agency), ISRO (India), JAXA (Japan), KARI (Republic of Korea), NASA (United States of America), SSAU (Ukraine), Roscosmos (Russia), UKSA (United Kingdom). "Space Agencies" refers to government organizations responsible for space activities.