Annual Report 2018

International Space Exploration Coordination Group – ISECG

ISECG was established in response to the "The Global Exploration Strategy: The Framework for Coordination" (GES) which was 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 results in documents, papers, findings and recommendations that are critical in informing individual agency decision making. In 2018, ISECG´s membership counted 15 space agencies. The title page captures the addition of the Australian Space Agency, Polish Space Agency, Romanian Space Agency, and Swiss Space Office. The members have been welcomed into ISECG in 2019, and demonstrate the increasing global importance of space exploration.

INTERNATIONAL SPACE EXPLORATION COORDINATION GROUP

ISECG Secretariat

Keplerlaan 1, PO Box 299, NL-2200 AG Noordwijk, The Netherlands

+31 (0) 71 565 5069

ISECG@esa.int

All ISECG documents and information can be found on:

http://www.globalspaceexploration.org/

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1 Executive Summary

The year 2018 started off with a major milestone for the ISECG, the publication of the updated version of the "Global Exploration Roadmap (GER)". The document puts specific emphasis on the benefits from space exploration, e.g. the important role of the advancement of science and knowledge. The third edition of the GER takes into account the dynamic developments in international space exploration in recent years, highlights the value of the deep space Gateway concept, as well as the growing private sector interest in space exploration. This shared roadmap embraces government and private sector strategies for expanding human presence in low Earth orbit, to the Moon and on to Mars.

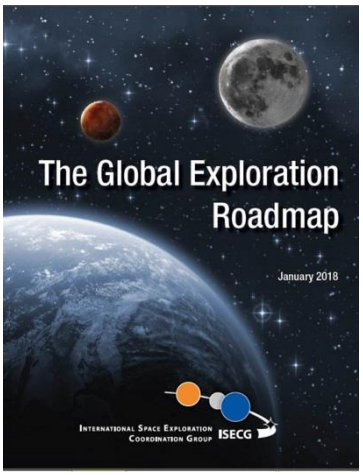
Throughout 2018, ISECG members pursued various activity lines, advancing the architectural and technology work as laid out in the GER. The progressing formulation of the Gateway was taken into account and its key functions were integrated in architecture trades and analysis studies, amongst others introducing an approach to increase sustainability and a transition to a permanent lunar exploration scenario. Various element concepts have been refined accordingly, such as a human pressurised rover and a human lunar lander. ISECG members also significantly advanced the characterisation and assessment of critical technologies related to the GER mission scenario. This has allowed participating members to inform their technology investment planning to create synergies and maximise their readiness to play a critical and visible part in the exploration endeavour. The group also advanced detailed study activities to assess technology gaps in discipline areas that traditionally had not been examined on an international level. Teams of subject-matter experts from participating members completed the gap assessment in the areas of 'Autonomous Systems' and 'Telerobotic Control of Robotic Systems with Time Delay'; identifying, amongst others, opportunities to coordinate technology investments amongst members. Additionally, a new study team was kicked off to assess technology gaps related to in-situ resource utilisation (ISRU). Furthermore, an overview of key technology related activities of the ISECG members can now be found on the ISECG website.

The updated version of the GER was completed in time to support the 2nd International Space Exploration Forum (ISEF2), which was held in March 2018 in Tokyo, Japan, with governmental representatives from 45 countries / international organisations, including 21 space agencies. Discussions focused on the importance of international cooperation for the sustainable promotion of space exploration, on benefits obtained and on common visions and goals. ISEF2 participating countries affirmed the widely shared goal of expanding exploration activities from low Earth orbit through the Moon, to Mars and beyond, and also took note of the newly updated GER.

In 2018 the ISECG published four webnews articles about: scientific opportunities of exploration beyond LEO; the update to the Global Exploration Roadmap; the 2nd International Space Exploration Forum (ISEF2); and the "ISECG Annual Report 2017".

2 ISECG Highlights, Achievements and Special Projects in 2018

Publication of the Update to the Global Exploration Roadmap



In February 2018, ISECG members released the updated version of the Global Exploration Roadmap (GER), first published in September 2011 and updated in August 2013. This shared roadmap embraces government and private sector strategies for expanding human presence in low Earth orbit, to the Moon and on to Mars. Refinements in this new edition include: A summary of the benefits stemming from space exploration; the important role of the advancement of science and knowledge; the introduction of an international deep space Gateway concept; and the recognition of the growing private sector interest in space exploration. Furthermore, this third edition of the GER includes updated agency plans and programmes and aims to facilitate stakeholder engagement within countries and across space members to realise human and robotic exploration of destinations where humans may one day live and work. The Global Exploration Roadmap demonstrates the growing interest in space exploration and the importance of cooperation to realise individual and common goals and objectives.

To download the updated GER, click here:
https://www.globalspaceexploration.org/wordpress/?p=779

Refinement of Architecture Elements

Throughout 2018, ISECG members continued to build upon the established reference lunar surface architecture documented in the GER. In addition, ongoing Gateway formulation activities were integrated to refine and drive architecture trades and analysis studies. The group considered an extension of the reference campaign with five missions, introducing an approach to increase sustainability and a transition to a permanent lunar exploration scenario.

Key accomplishments were:

Initial identification, evaluation, and promotion of key functions needed on Gateway to enable interfaces with elements designed for lunar surface operations (e.g. communications, refuelling, servicing, rendezvous, sample handling); Assessment of compatibility of a robotic sample return mission concept of operations with Gateway functions and operations; Advancement of a concept for a small human lunar pressurized rover through refining design aspects for both lunar and Mars exploration, in particular considering options for night survival and specifics on the operational concept; Refinement of human lunar lander concepts, including incorporation of studies from all participating members.

Technology and Gap Assessment Analysis

In the area of advanced technologies, ISECG members continued to undertake a thorough review of the GER Critical Technology Portfolio, whereby subject-matter experts from participating members validated the individual technology descriptions, performance characteristics and categorisation into the NASA Technology Area Breakdown Structure (TABS). This categorisation is a key for the portfolio analysis and mapping to agency technology

development plans and activities. Special emphasis was given to the maturation of the definition of the GER Critical Technology Portfolio.

Key products:

The detailed gap analysis focused on the assessment of 'Autonomous Systems' and 'Telerobotic Control of Robotic Systems with Time Delay'. The group identified technology gaps related to, but not limited by, the current GER mission scenario and revealed 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. Both assessments have been completed. The study report on 'Telerobotic Control of Robotic Systems with Time Delay' has already been published on the new ISECG website dedicated to ISECG members activities related to Advanced Technologies:

https://www.globalspaceexploration.org/wordpress/?page_id=811

2nd International Space Exploration Forum (ISEF2)

A highlight in international space exploration was the 2nd International Space Exploration Forum (ISEF2) Ministerial Meeting, held on March 3, 2018 in Tokyo, Japan, with representatives from 45 countries / international organizations, including 21 space agencies. During the day-long meeting, ISEF participants discussed the importance of space exploration and the benefits obtained, common visions and goals, and future international cooperation. In a joint statement participants recognized that space exploration is an important challenge for expanding human activity areas and acquiring knowledge, experience, and benefits common to humankind. ISEF2 participating countries affirmed the widely shared goal of expanding exploration activities from low Earth orbit through the Moon, to Mars, and beyond. Amongst other things, ISEF2 participating countries also took note of the GER newly issued by ISECG.

3 Outlook for 2019/2020

ISECG Working Groups

Exploration Roadmap Working Group (ERWG)

The ERWG will continue its efforts to find cooperation and collaboration opportunities across planned lunar robotic and human explorations missions, including promoting data sharing of important information on the lunar volatiles and science missions necessary to formulate the role of In Situ Resource Utilization into exploration planning. The ERWG will also focus on the refinement of the ISECG lunar surface scenario with the IAWG in order to identify potential areas of collaboration as many ISECG members express further plans for the exploration of the Moon. The Analogue Team will also continue to meet quarterly and share lessons learned and collaboration opportunities.

International Architecture Working Group (IAWG)

The IAWG will continue to refine the beyond-LEO architectures. The IAWG will primarily focus on the lunar surface architectures, but will keep anchoring capabilities and technologies pointed to the horizon goal of humans to Mars. As agency plans continue to mature, the architecture will be updated to fit accordingly. Specifically, IAWG will work with ISECG members to identify and refine the goal to evolve the capability of robotic lunar landers from small scale cargo landers to full scale human landers including consideration of plans identified by potential commercial providers. In addition, as international human lunar surface goals and objectives evolve, details on the design of the lunar surface assets, concept of operations, and supporting technologies will be aligned to reflect maturing space agency plans, envisioned commercial capabilities and updated plans for Mars exploration.

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 2019;
- Providing support of ISECG publications and ISECG contributions to international conferences;
- ISECG outreach activities such as the Stakeholder Engagement Tiger Team (SETT) (Converging concepts for spacecraft and exploration hardware capabilities in fulfilling communication and outreach needs with projected technologies available in the coming decades)
- Preparation of key messages and success stories to communicate benefits from space exploration.

Technology Working Group (TWG)

In 2019, the TWG will continue to advocate coordination and collaboration in technology development efforts of individual ISECG space members in support of the GER. In particular, the TWG will perform a technology gap identification and closure analysis focused on the critical technologies related to ISRU as well as continue to identify opportunities for collaborative technology development. The release of the gap assessment report ‘Autonomous Systems’ as well as the ‘GER Critical Technology’ document are anticipated.

Major Events

- 35th Space Symposium — Colorado Springs/USA, 08-11 April 2019
- Humans to Mars Summit 2019 — Washington D.C./USA, 14-16 May 2019
- 69th International Astronautical Congress (IAC) — Washington D.C./USA, 21-25 October 2019
- 36th Space Symposium — Colorado Springs/USA, 30 March-02 April 2020
- GLEX, Global Space Exploration Conference — St. Petersburg/Russia, 09-11 June 2020
- 70th International Astronautical Congress (IAC) — Dubai/UAE, 12-16 October 2020

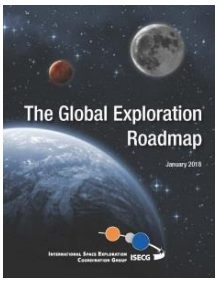
Annex I

Publications

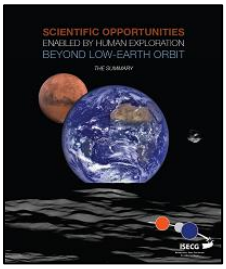
ISECG Webnews 2018

- Scientific opportunities of exploration beyond LEO — January
- ISECG Publishes Update to the Global Exploration Roadmap — February
- Government representatives from 45 countries and international organisations meet at the 2nd International Space Exploration Forum (ISEF2) — March
- ISECG Annual Report 2017 published — May

Major ISECG Documents

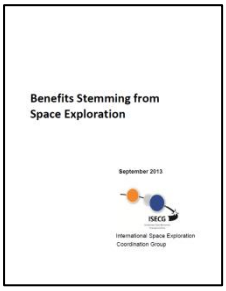


The Global Exploration Roadmap (GER), January 2018

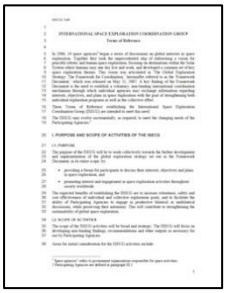


Scientific Opportunities enabled by Human Exploration beyond Low Earth Orbit – The Summary
(summary version)

Scientific Opportunities enabled by Human Exploration beyond Low Earth Orbit – A ISECG Science White Paper
(full version)



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 (status of June 2019)

Australia		Australian Space Agency (ASA) (Member since 2019)
		Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Canada		Canadian Space Agency (CSA)
China		China National Space Administration (CNSA)
Europe		European Space Agency (ESA)
France		Centre National d'Études Spatiales (CNES)
Germany		Deutsches Zentrum für Luft- und Raumfahrt (DLR)
India		Indian Space Research Organisation (ISRO)
Italy		Agenzia Spaziale Italiana (ASI)
Japan		Japan Aerospace Exploration Agency (JAXA)
Poland		Polish Space Agency (POLSA) (Member since 2019)
Republic of Korea		Korea Aerospace Research Institute (KARI)
Romania		Romanian Space Agency (ROSA) (Member since 2019)
Russia		State Space Corporation Roscosmos
Switzerland		Swiss Space Office (SSO)

Ukraine		State Space Agency of Ukraine (SSAU)
United Arab Emirates		United Arab Emirates Space Agency (UAE Space Agency)
United Kingdom		United Kingdom Space Agency (UKSA)
USA		National Aeronautics and Space Administration (NASA)

Annex III

ISECG Working Groups

ISECG Working Groups

Exploration Roadmap Working Group (ERWG)

The ERWGleads the human spaceflight roadmapping effort which is intended to establish a common roadmap, and common framework to promote partnerships in realizing exploration missions. A summary of their work is communicated in regular updates of the Global Exploration Roadmap.

International Architecture Working Group (IAWG)

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

Science Working Group (SWG)

The Science Working Group coordinates with the international science communities on exploration planning and activities as required for the generation of ISECG products. Through the development of the Science White Paper, the SWG has established a Science Advisory Group, developed links into the global science community and coordinated activities with relevant science organisations. The SWG will continue to do so, recognising the strong role of science and the scientific opportunities in future exploration efforts.

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 members in support of the GER. The strategic nature of technology investments and the desire of members to focus investments to maximise their contribution potential while enabling meaningful and achievable opportunities for all participating ISECG members must hereby be recognised.

Annex IV

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 members' mutual efforts in space exploration. ISECG also supports promoting interest and engagement in space exploration activities throughout society. In 2018, ISECG membership counted 15 space agencies[1].

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 space 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 members.
- 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, an initial group of 14 space agencies 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), UAE Space Agency (United Arab Emirates), UK Space Agency (United Kingdom). "Space Agencies" refers to government organizations responsible for space activities.