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 2020, ISECG’s membership increased by six, to 26 organisations, demonstrating the increasing global importance of space exploration.
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1 Executive Summary

In the summer of 2020, ISECG released the ‘Global Exploration Roadmap, Supplement August 2020’. The Supplement provides additional details to the lunar surface exploration scenario originally published in the 2018 Global Exploration Roadmap (GER). Since then, global interest in space exploration has further grown and ISECG membership has expanded to 26 agencies by the end of 2020. Many of these space agencies have renewed their focus on the exploration of the Moon. The Supplement captures the latest developments in lunar exploration planning in an updated Lunar Surface Exploration Scenario. It describes an exploration campaign and architecture elements that could be employed to progressively address a set of twelve ISECG lunar surface exploration objectives, while leveraging the ISECG goals and sustainably principles outlined in the 2018 GER. Ultimately, the Supplement describes emerging national and commercial capabilities to enable lunar initiatives that will serve as preparation for missions to Mars and for further activities on the Moon.

Understanding performance characteristics of advanced technologies and identifying technology gaps is key to thoroughly prepare for future mission scenarios. ISECG continued to review the GER Critical Technology Portfolio with support of subject-matter experts from participating agencies, focusing on portfolio analysis and a mapping to agency technology development plans and activities. In parallel, detailed gap analysis activities focused on the assessment of ‘Autonomous Systems’, ‘In-situ Resource Utilisation (ISRU)’, and ‘Nuclear Power and Propulsion (NPP)’. Identification of technology gaps revealed opportunities for international coordination and cooperation, along with specific recommendations for closing the identified gaps. Furthermore, the gap closure analyses also considered synergies between applications in missions to the Moon and to Mars.

ISECG has continued to grow substantially over the past three years. Space agencies consider the work of ISECG supportive of their own national priorities, and they seek to engage in focused international strategic exchange and coordination and to build new strategic partnerships. In 2020 ISECG agencies welcomed six new members:

- AEB, Brazilian Space Agency (Agência Espacial Brasileira)
- AEM, Mexican Space Agency (Agencia Espacial Mexicana)
- GISTDA, Geo-informatics and Space Technology Development Agency (Thailand)
- NOSA, Norwegian Space Agency
- PTS, Portugal Space
- VNSC, Vietnamese National Space Center

The ISECG published five webnews articles in 2020, addressing the following topics:

- Senior Agency Managers meeting to advance exploration planning
- Six new members joined ISECG between autumn 2019 and spring 2020, from Australia (ASA), Luxembourg (LSA), Norway (NOSA), Romania (ROSA), Switzerland (SSO) and Vietnam (VNSC)
- Publication of the “ISECG Annual Report 2019”
- Publication of the “Global Exploration Roadmap Supplement – August 2020”
- ISECG Senior Agency Managers meeting to advance coordination in Moon and Mars exploration
2 ISECG Highlights, Achievements and Special Projects in 2020

Release of the ‘Global Exploration Roadmap, Supplement August 2020’

In summer 2020, ISECG released the ‘Supplement August 2020’ to the Global Exploration Roadmap (GER). The Supplement provides several updates and additional details to the lunar surface exploration scenario originally published in the 2018 Global Exploration Roadmap. It reflects the rapidly maturing lunar exploration plans across many agencies with the scenario driven by recent updates to the set of lunar surface exploration objectives and associated performance measures. The GER Supplement also captures short overviews of the new ISECG agency members as well as the strategy of achieving lunar surface objectives with a phased approach. This strategy builds on a phased approach to develop exploration capabilities over time in order to prepare for a sustained lunar surface presence as well as establishing the technical and research abilities needed to prepare and embark on future missions to Mars. Lastly, the Supplement recognizes the increasingly capable private sector, which is providing space exploration services to a broader market than previously available under traditional government acquisition approaches, thus offering potential benefits to lowering the space exploration costs of all agencies over time.

Technology and Gap Assessment Analysis

In the area of advanced technologies, ISECG continued to undertake a thorough review of the GER Critical Technology Portfolio, whereby subject-matter experts from participating agencies validated the individual technology descriptions and performance characteristics. Such advanced technologies were subject of a categorisation according to the NASA Technology Area Breakdown Structure (TABS). This categorisation is key for the portfolio analysis and mapping to agency technology development plans and activities. The most recent definition of the GER Critical Technology Portfolio was completed in December 2019 and is available on the ISECG Website.

The detailed gap analysis activities focused on the assessment in the areas of ‘Autonomous Systems’, ‘In-situ Resource Utilisation (ISRU)’, and ‘Nuclear Power and Propulsion (NPP)’. Identification of technology gaps was related to, but not limited by, the current GER mission scenario. It revealed opportunities for international coordination and cooperation, along with specific recommendations for closing the identified gaps. Furthermore, the gap closure analyses also considered synergies between applications in missions to the Moon and to Mars.

The gap assessment analysis on ‘Autonomous Systems’ focused on various topics, including Vehicle Autonomy, Crew Autonomy, Crew Health and Performance Autonomy, Food Production, Robotic Caretakers and Stowage Management. The study was completed in May 2020 and the ‘Autonomous Systems’ report was published on the ISECG Advanced Technologies webpage.

Analysing ISRU technologies work focused on identification of Strategic Knowledge Gaps (SKGs), assessment of key ISRU domains, along with their associated crosscutting challenges, opportunities for partnership, and private sector involvement. Key ISRU domains include, among others, in-situ propellant and consumable production, in-situ construction, and in-space manufacturing. This ISRU gap assessment report is set for release in early 2021.

Gap assessment in the area of ‘Nuclear Power and Propulsion’ kicked-off in late 2020 and will, amongst others, unlock key power and propulsion solutions for the exploration of the Moon, Mars, and beyond.
3  Outlook for 2021

ISECG Working Groups

**Exploration Roadmap Working Group (ERWG)**
and **International Architecture Working Group (IAWG)**

The ERWG and IAWG will work to evaluate any needed updates to the GER (2018) and GER Supplement in order to determine a recommendation on the necessity of a revision. The IAWG will continue working on refinements to the IAWG products including the areas of objectives, concept of operations, and support technology gap assessments through lunar surface element description studies. The ERWG will also focus on enhancing the sharing of experiences and lessons learned amongst ISECG space agencies with regards to commercialization and public private partnerships in space exploration and how these can be best advanced. Potential methods of strengthening the advantages of diverse acquisition methodologies include establishment of a long-term working group and fostering increased participation in Earth-based analog capabilities.

**Technology Working Group (TWG)**

In 2021, the TWG will continue to advocate coordination and collaboration in technology development efforts of individual ISECG space agencies in support of the updated GER per the GER Supplement of August 2020.

In particular, the TWG will be completing the Gap Assessment Analysis on ISRU; the gap assessment report ‘In Situ Resource Utilisation’ will be released, in spring 2021.

In addition, the TWG will continue the identification of technology gaps and closure analysis focused on the critical technologies related to Nuclear Power and Propulsion. The technologies to be analysed will be, among the others, Nuclear Thermal Propulsion, Fission Power for Surface Missions and Multi-MWe Nuclear Power for Electric Propulsion.

Following the NASA TABs categorization mapping to the new NASA Taxonomy 2020 architecture last year, the TWG will be working on updating their GER Critical Technologies and agency technologies mapping to this new taxonomy in 2021. The TWG will also continue to advance the high-level analysis of the overall technology portfolio.

**Strategic Communications Working Group (SCWG)**

The SCWG will continue to implement and coordinate communication of the ISECG work, its products and activities. A major activity will be the Tiger Team initiative about ‘Public Engagement in Future Lunar Exploration’. This activity aims to gather key messages related to benefits associated to lunar exploration, in particular related to the GER Supplement, as well as best practices and lessons learned from communication to the broad public. The Tiger Team is open to all ISECG agencies and is co-chaired by DLR and ESA. Further activities will comprise the publication of ISECG webnews, as appropriate, and the preparation of the ISECG Annual Report 2021. Furthermore, the SCWG will support ISECG publications and ISECG contributions to international conferences. The SCWG has started to review the contents of the ISECG website and will continue this work throughout 2021.
Major International Events Related to Space Exploration

Underlined events will include ISECG presentations. (Status April 2021)

NOTE: Changes of dates are possible due to the Corona virus pandemic

- **36th Space Symposium**
  Colorado Springs/USA, 23-26 August 2021

- **GLEX, Global Space Exploration Conference**
  St. Petersburg/Russia, 14-18 June 2021

- **72nd International Astronautical Congress (IAC)**
  Dubai/UAE, 25-29 Oct. 2021

- **(73rd International Astronautical Congress (IAC)**
  Paris/France, 18-22 Sept. 2022)

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Annex I

Publications

**ISECG Webnews 2020**

- International Space Agencies Meet to Advance Exploration Planning
  March

- ISECG Membership is Further Enlarging – Six New Members
  April

- ISECG Annual Report 2019 published
  May

- Global Exploration Roadmap Supplement
  – Lunar Surface Exploration Scenario Update
  August

- International Space Agencies Meet to Advance Coordination in Moon and Mars Exploration
  September
Major ISECG Documents

**Global Exploration Roadmap, Supplement August 2020**
– Lunar Surface Exploration Scenario Update

**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 March 2021)
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Annex III

ISECG Working Groups

**ISECG Working Groups**

**Exploration Roadmap Working Group (ERWG)**

The ERWG leads the human spaceflight roadmapping effort which is intended to establish 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 GER.

**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 characterising 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.
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. By the end of 2020, ISECG membership counted 26 government organisations responsible for space activities.

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).

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1 In alphabetical order: AEB (Brazil), AEM (Mexico), ASA and CSIRO (Australia), ASI (Italy), CNES (France), CNSA (China), CSA (Canada), DLR (Germany), ESA (European Space Agency), GISTDA (Thailand), ISRO (India), JAXA (Japan), KARI (Republic of Korea), LSA (Luxembourg), NASA (United States of America), NOSA (Norway), POLSA (Poland), PT Space (Portugal), ROSA (Romania), Roscosmos (Russia), SSAU (Ukraine), SSO (Switzerland), UAE Space Agency (United Arab Emirates), UK Space Agency (United Kingdom) and VNSC (Vietnam).