ISECG SWP

LEAG, 20 October 2015

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About ISECG

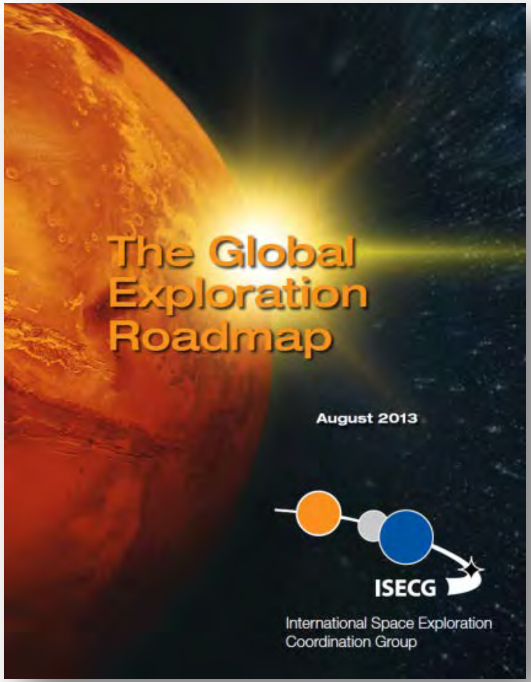
- **ISECG is a non-political agency coordination forum of 14 space agencies**
  - Website: www.globalspaceexploration.org

- **Work collectively in a non-binding, consensus-driven manner towards advancing the Global Exploration Strategy**
  - Provide a forum for discussion of interests, objectives and plans
  - Provide a forum for development of conceptual products
  - Enable the multilateral or bilateral partnerships necessary to accomplish complex exploration missions
  - Promote interest and engagement in space exploration among citizens and society

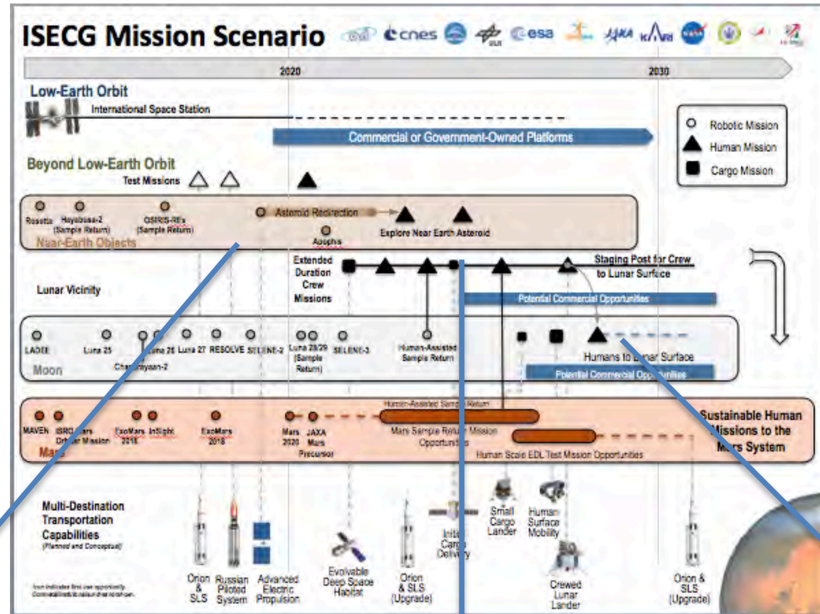
- **ISECG operating principles**
  - Open and inclusive
  - Flexible and evolutionary
  - Effective
  - Mutual interest

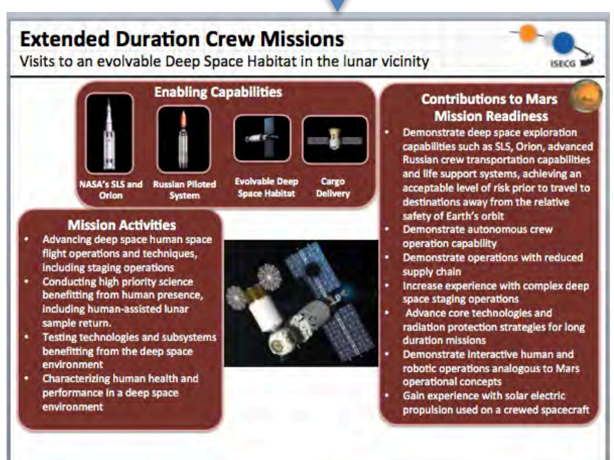
About the Global Exploration Roadmap

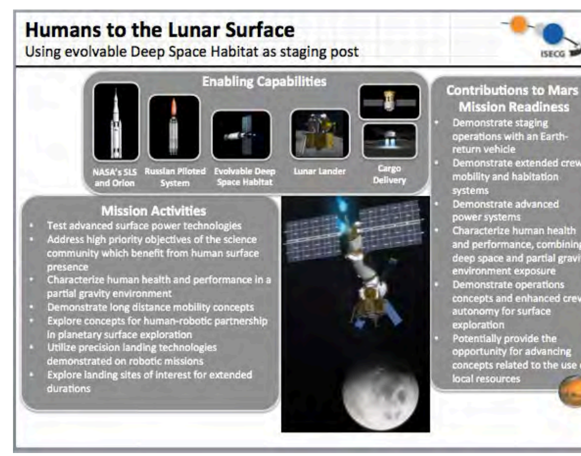
- **The GER is a human space exploration roadmap, recognizing the criticality of increasing synergies with robotic missions while demonstrating the unique and important role humans play in realizing societal benefits**
- **The non-binding document reflects a framework for agency exploration discussions on:**
  - Common goals and objectives
  - Long-range mission scenarios and architectures
  - Opportunities for near-term coordination and cooperation on preparatory activities
- **Since release of updated GER in August 2013, participating agencies have continued discussions and joint work in several areas which are of mutual interest**
  - Increase understanding of design reference missions for early mission themes
- **Highlighting opportunities for the science community with a dedicated Science White Paper and within the GER itself is a priority**



GER Mission Themes







GER Destination Themes Reference Missions

Cislunar Deep Space Habitat

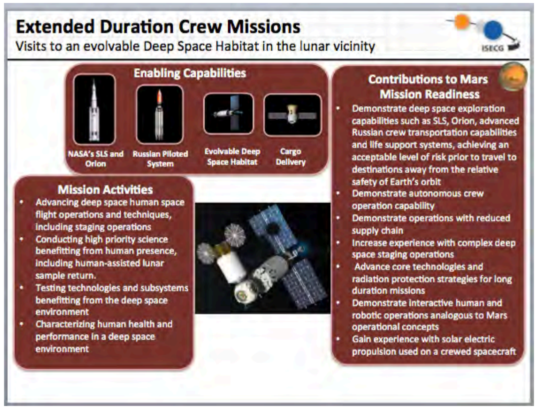
- Crew of four
- Initially annual missions lasting 30 days
- Increase both duration & frequency later in the decade.

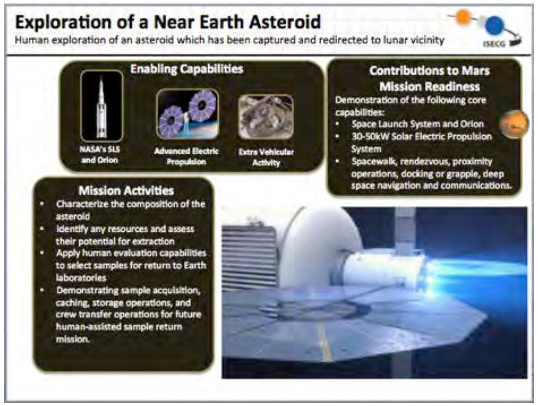
Near Earth Asteroid in Cislunar space

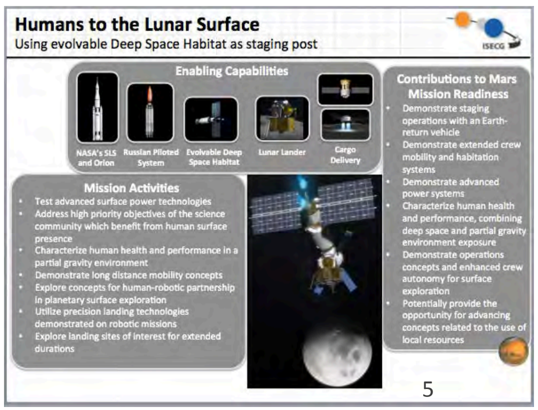
- Boulder collected using SEP-based s/c
- Crew of two visits asteroid boulder in lunar DRO

Lunar Surface

- Five 28-day missions with a crew of four
- One mission per year
- Reuse pressurized rover for each mission
- Rover is moved to next landing site in between crewed visits







ISECG Interaction with Scientific Communities

- **ISECG agencies acknowledge science communities as major stakeholders and scientific knowledge gain as important benefit of exploration activities.**
  - Scientists in general support GER and want to engage in the discussion.

- **Several agencies agreed in winter 2014/15 to facilitate interaction**
  - ASI, **CNES**, CNSA, CSA, **DLR**, ESA, JAXA, NASA, SSAU, UKSA (+ESF, SSERVI)

- **Objectives**
  - Coordinate **interaction with the science communities** on exploration planning and activities as required for the generation of ISECG products
  - Advance the development of a **Science White Paper** for the articulation of science opportunities in the GER in conjunction with the science communities

Science White Paper – Concept & Scope

- **Describe an international view of the science that could be enabled by human missions in the GER**
  - Engage the scientific communities in identifying these opportunities
  - Target the same stakeholder community as the GER
  - Focus on human missions and human/robotic concepts
  - Incorporate activities that have feed-forward benefits to Mars exploration

- **Incorporate interdisciplinary scientific topics that**
  - Encompass all relevant science communities and disciplines: planetary science, space science, life sciences, astrobiology, astronomy, physical sciences, etc.
  - Span all destinations (LEO, cis-lunar space, Moon, asteroids, Mars)
  - Incorporate input from the international science communities

Science Advisory Group Membership

- **Co-chairs:**
  1. Ben Bussey (NASA, USA) david.b.bussey@nasa.gov
  2. Jean-Claude Worms (ESF, France) jcworms@esf.org

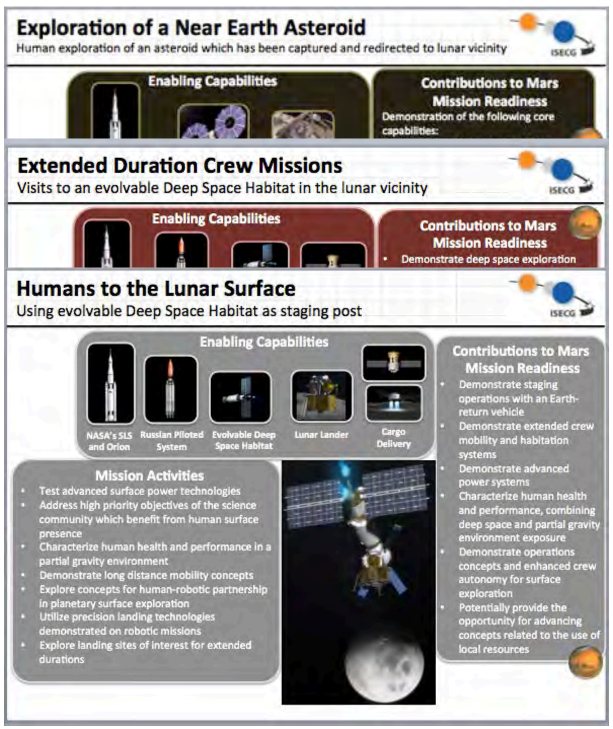
- **Members**
  3. Gilles Clement (Univ. of Lyon, France) gilles.clement@inserm.fr
  4. Ian Crawford (Univ. of London, UK) i.crawford@ucl.ac.uk
  5. Mike Cruise (Univ. of Birmingham, UK) a.m.cruise@bham.ac.uk
  6. Masaki Fujimoto (JAXA, Japan) fujimoto@stp.isas.jaxa.jp
  7. Dave Hart (Univ. of Calgary, Canada) hartd@ucalgary.ca
  8. Ralf Jaumann (DLR, Germany) Ralf.Jaumann@dlr.de
  9. Clive Neal (Notre Dame Univ., USA) neal.1@nd.edu
  10. Gordon Osinski (Univ. of West. Ontario, Canada) gosinski@uwo.ca
  11. Masaki Shirakawa (JAXA, Japan) shirakawa.masaki@jaxa.jp
  12. Tim McCoy (Smithsonian, USA) mccoyt@si.edu
  13. Maria Cristina De Sanctis (INAF, Italy) mariacristina@iaps.inaf.it

- **Executive Secretary**
  - Greg Schmidt (SSERVI, USA) gregory.schmidt@nasa.gov

Science White Paper – Development Process

- **Apply a transparent, interactive process that stimulates discussion on science opportunities in preparation of GER3**

GER Mission Themes



SWP Concept & Scope	Oct. 2014	ISECG agencies
Overarching Science Topics		Authors from science communities (led/guided by international Science Advisory Group)
Science Opportunities		Authors from science communities (led/guided by international Science Advisory Group)
Editing & Review		Authors from science communities (led/guided by international Science Advisory Group) / ISECG agencies
SWP Publication	Fall 2016	ISECG agencies

SWP Structure

Table of Contents (as of 10/2015) – total ~20 pages

- **Scope & Purpose**
  - Broad interaction between science communities and ISECG agencies
- **Exec. Summary (2)**
- **1. Linkage to GER (2)**
  - GER approach
    - Connect to Goals & Objectives
    - Long-term horizon goal (Mars)
    - Near-term destination focus
  - Human-robotic partnership / Value of human presence
- **2. Science Topics (2)**
  - Introduce topics
  - Spans all destinations
  - Incl. many scientific disciplines
- **3. Cislunar Deep Space Habitat (4)**
- **4. NEA in Cislunar Space (4)**
- **5. Lunar Surface (4)**
  - Each chapter 3-5 to highlight
    - Short summary of the mission theme including DRMs
    - Scientific opportunities structured by science topics
    - Science findings
- **Conclusion (1)**
- **References (1)**
  - E.g. GER2, COSPAR PEX, Decadal Surveys, MEPAG report, ILEWG, others, …

SAG-SWP Process

- **Each destination chapter has 2 SAG co-leads**
  - Science Opportunities of a Cislunar Deep Space Habitat
    - » Co-Leads: Giles Clement & Gordon Osinski
  - Science Opportunities at a NEA in Cislunar space
    - » Co-Leads: Masaki Fujimoto & Tim McCoy
  - Science Opportunities on the Lunar Surface
    - » Co-Leads: Ian Crawford & Clive Neal
  - Other SAG members may choose to support one or more chapters

- **Chapter co-leads solicit input from subject experts in the community**

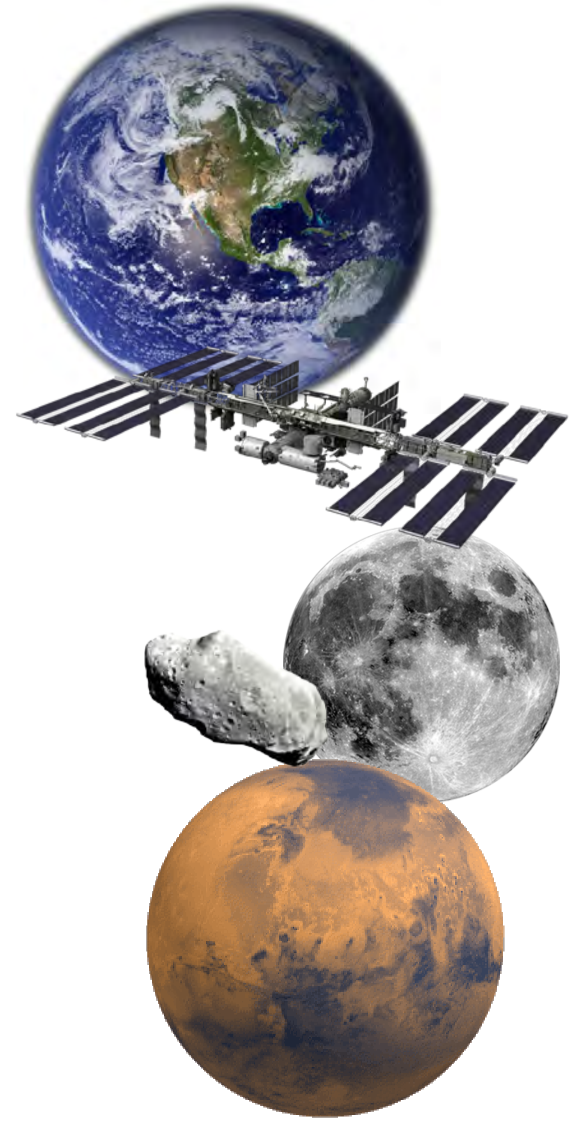
- **Additional community 2-way interaction and feedback by presenting initial science ideas at major meetings**
  - European Lunar Symposium, Small Bodies Assessment Group (SBAG), Lunar Exploration Analysis Group (LEAG), ESA Moon 2020-2030 Workshop
  - SWP COSPAR/SWG workshop planned for February 2015 in Paris

SWP Science Topics

Living and working in space

- Overarching questions:
  - How do we become a spacefaring species?
  - How do we sustain life outside Earth?

- Disciplines involved, e.g.
  - Human physiology, life sciences and life support
  - Prospecting and utilising local resources



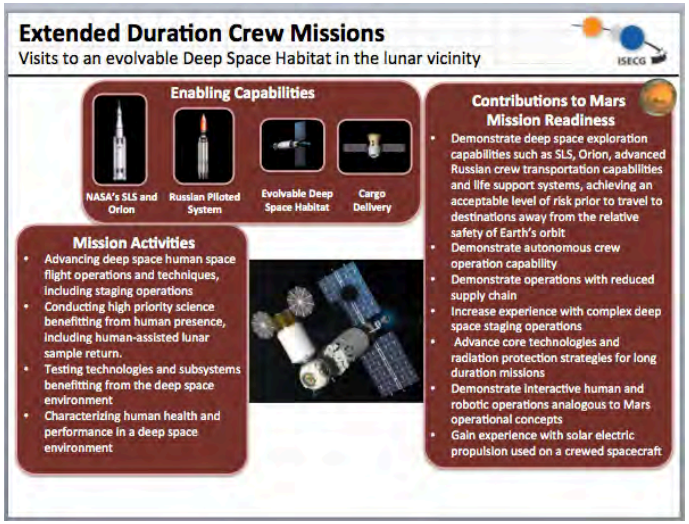
Our place in the universe

- Overarching question:
  - How do terrestrial planets form and evolve?
  - How does life evolve in the planetary environment?

- Disciplines involved, e.g.
  - Astronomy
  - Planetary geology
  - Solar physics, space physics
  - Astrobiology (understanding the building blocks of life)

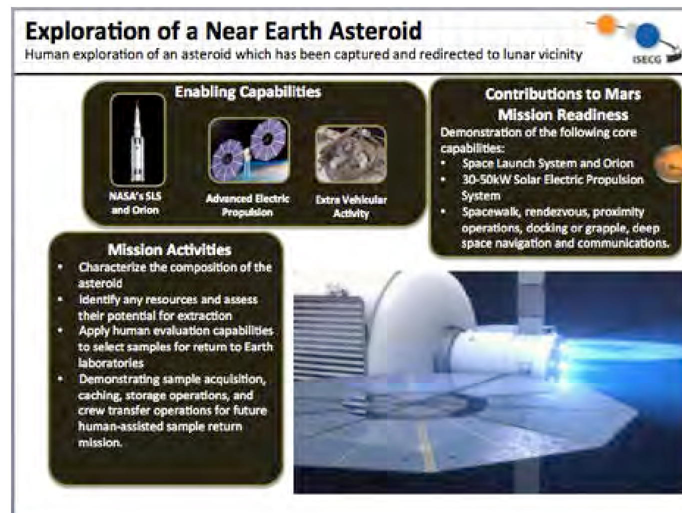
Science Enabled by Humans to a Cislunar Habitat

- **Human-assisted lunar sample return**
  - Increased return through more and improved selection of lunar samples
- **Construct and/or service large space telescopes**
- **Understand combined effects of radiation/reduced-gravity/isolation on humans**
- **Monitor Earth's climate to help design exoplanet observing instrument**
- **Facilitate access to challenging regions by low-latency telerobotics (e.g. permanently shadowed crater floors)**
  - Telerobotics experience useful for Mars exploration

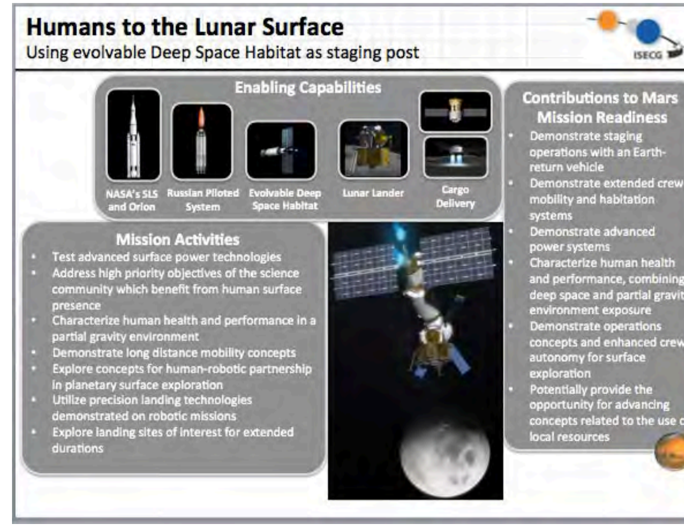


Science Enabled by Humans to a NEA

- **Sample return provides key science**
  - Humans permit careful selection of samples for high sample quality
  - Larger sample return mass compared to robotic missions
  - Increase the value of the current meteorite collections
  - Provide an archive of samples for analyses that must be done on Earth
- **Increased surface access**
  - Multiple drilling sites
  - Exposure ages at different depths
- **Instrument deployment**
  - Placing instruments on the surface enabled by humans
  - Long-term instrument deployment



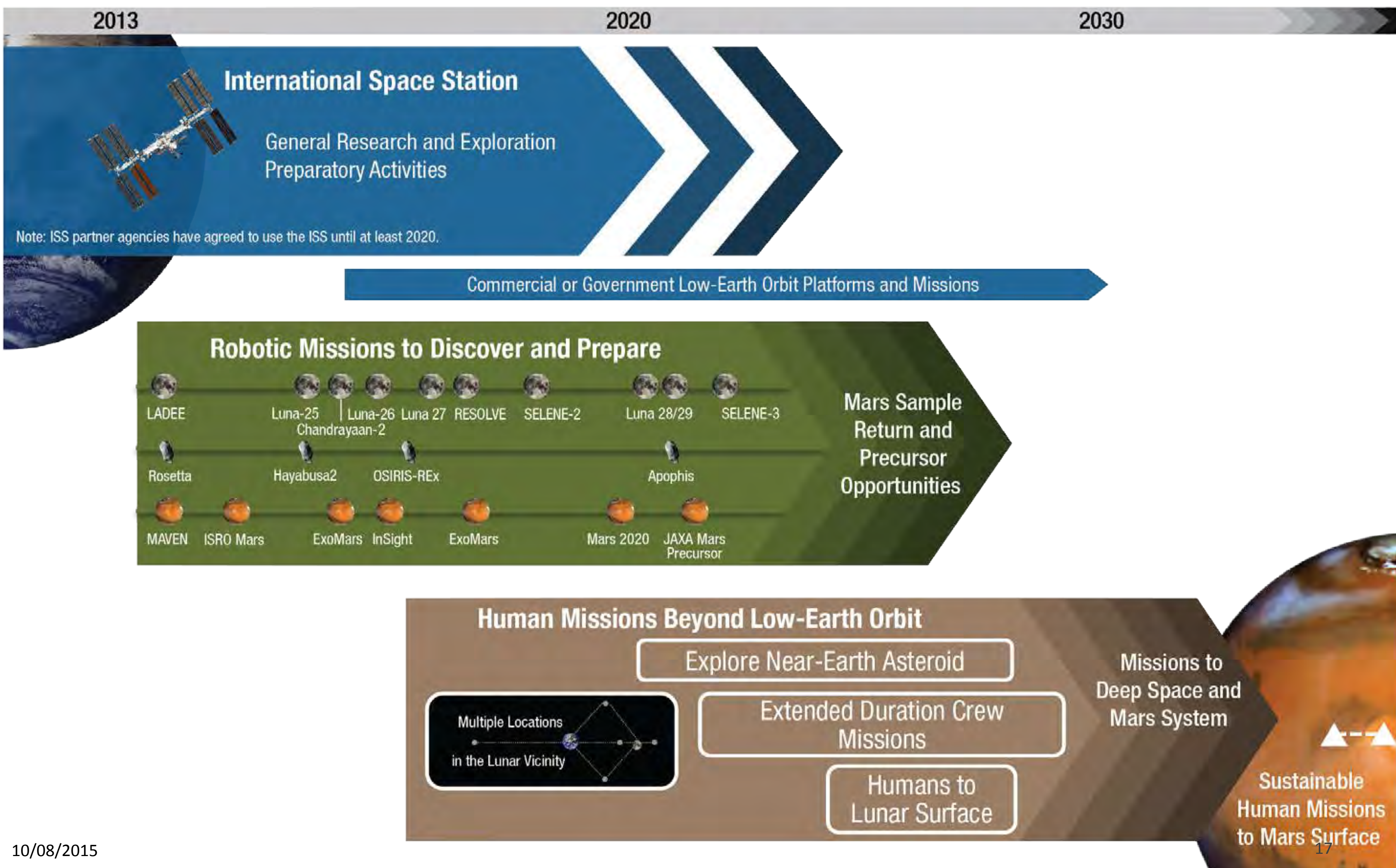
Science Enabled by Humans to the Lunar Surface



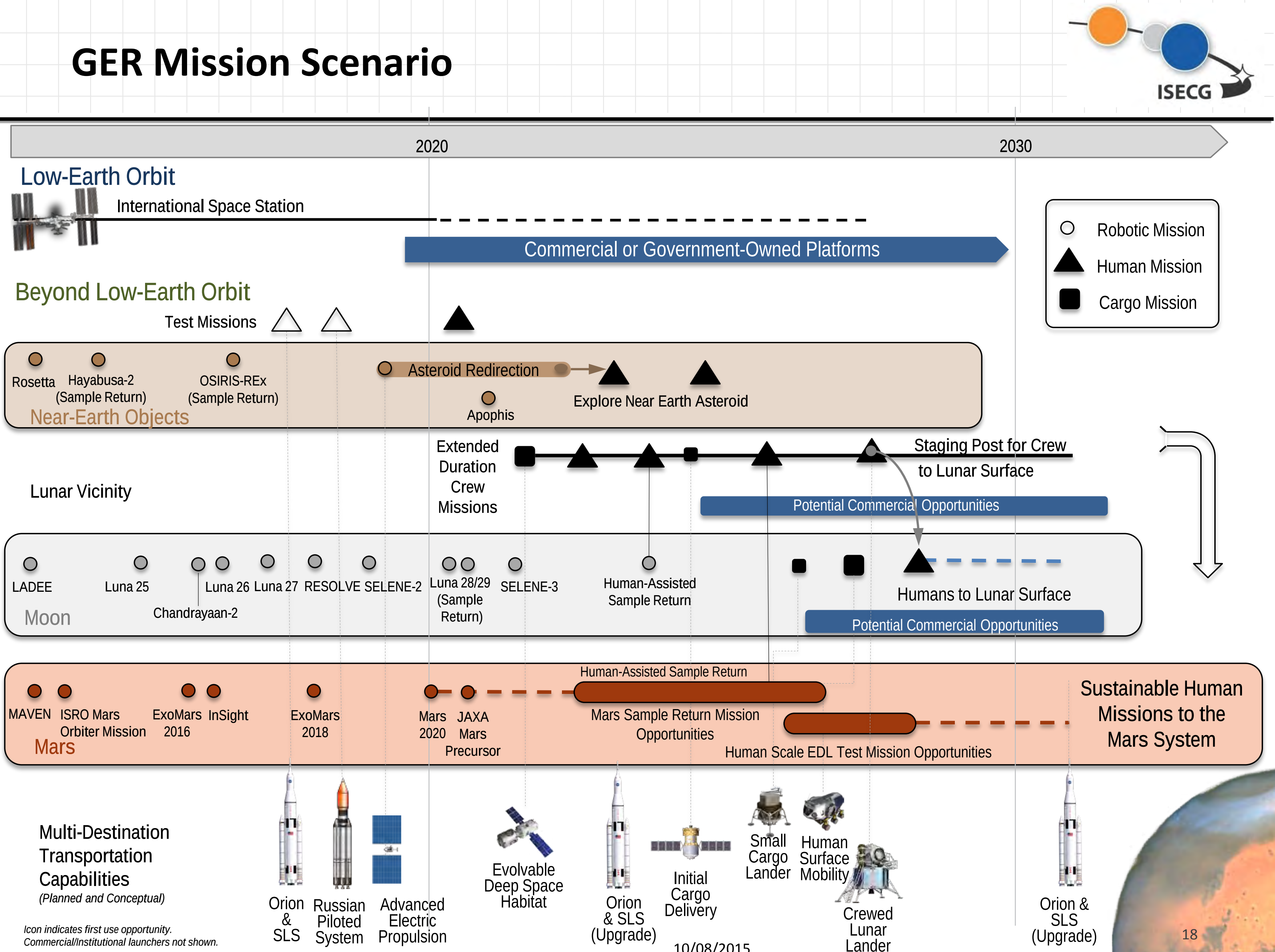
- **Sample return provides key science**
  - Humans best at identifying scientifically important samples
  - Improve our understanding of impact cratering
  - Provide insight into the evolution of the terrestrial planets
  - Study the history of the Sun
- **Understand lunar volatiles**
  - Record of the flux and composition of volatiles
  - Help answer astrobiological questions
  - Install and maintain resource utilization equipment (i.e. generate water)
- **Emplacement of delicate or large astronomical instruments**
- **Understand the physiological effects of the lunar environment on human health, contributing to medical benefits on Earth**
- **Understand how plants and other non-human forms of life adapt to, or can be protected from, the conditions on hostile planetary surfaces**
- **Feed-forward activities (using the Moon as a gateway to the Solar System)**

Backup-Slides

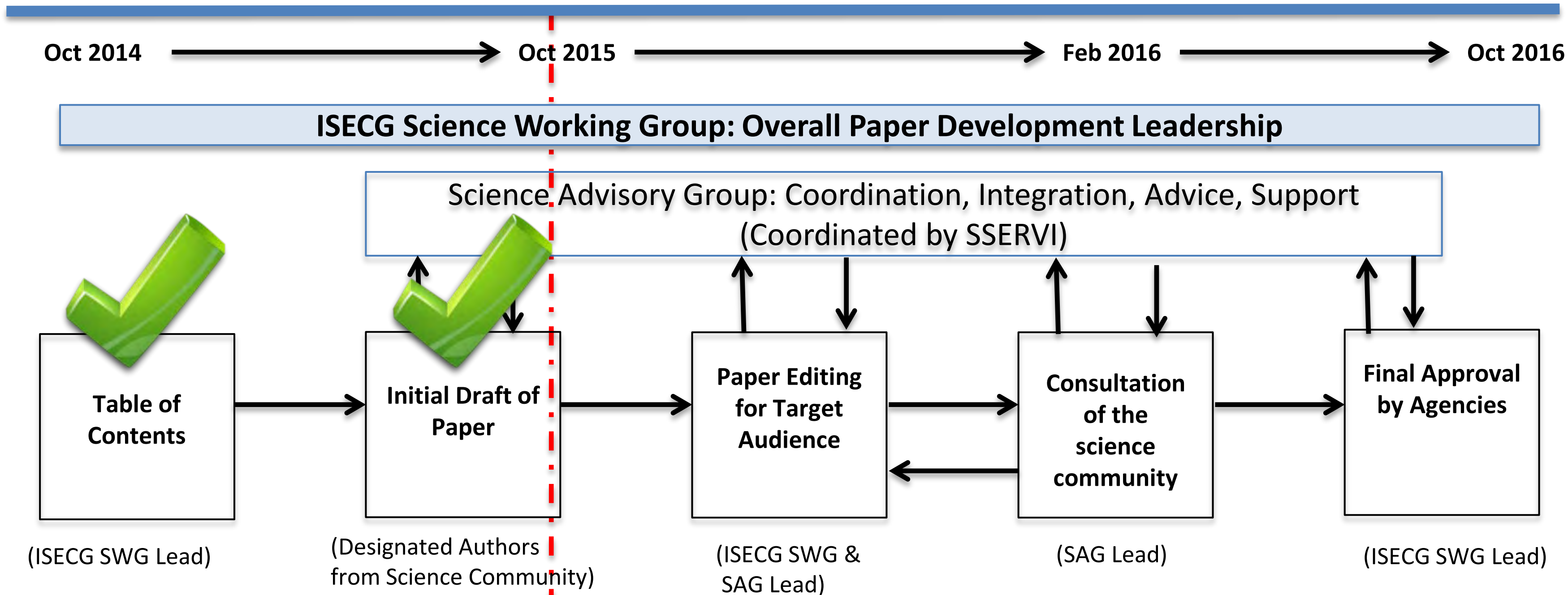
The Global Exploration Roadmap



GER Mission Scenario



SWP Development Process



- Develop Table Of Contents
- Identify Existing Content
- Identify Stakeholder Groups
- Identify Science Advisory Group members

- Identify Authors
- Develop first draft of assigned section
- Identify references

- Edit draft sections to impact target audiences

- COSPAR-PEX / ISECG-SWG workshop
- Discussion of draft SWP

- Agencies to follow their own processes for approval (including relevant agency advisory groups)