



# Science & Exploration **Deep Space Gateway** Workshop

A forum to articulate science enabled by  
near-term human space exploration

# Introduction



- Science and Research are essential elements of Human Exploration
- Early integration of Science and Research goals and objectives into Human Exploration architectures is important

*We propose a workshop whose outcome is a publically disseminated product that articulates SMD investigations and HEOMD Life Science research, including international collaborations, that are made possible by the new opportunities in space that result from the Deep Space Gateway*

# ISECG Science White Paper

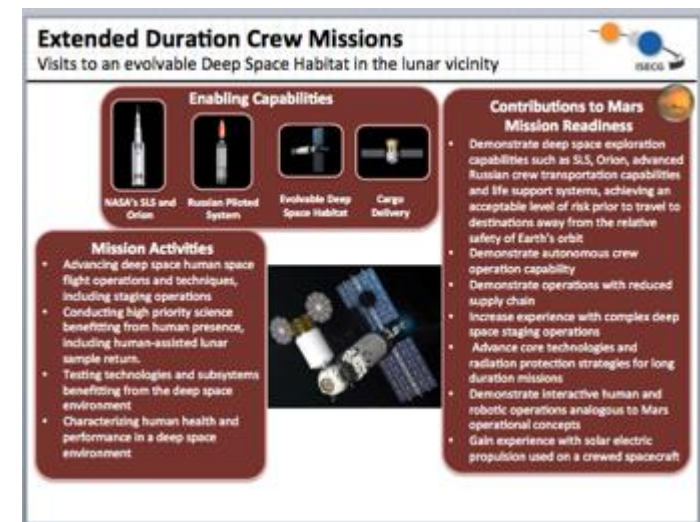


- **This idea leverages off the recent ISECG science white paper study.**
- ISECG agencies acknowledge science communities as major stakeholders and scientific knowledge gain as an important benefit of, and justification for, human exploration activities
- A Science White Paper (SWP) has been developed by the international science community
  - ***Describes the international view of the science enabled by human exploration after ISS, as outlined in ISECG's Global Exploration Roadmap***
  - Tasked with considering the three destinations outlined in the GER
    - DSG in the lunar vicinity, Lunar surface, Asteroids
  - Engaged the scientific communities in identifying these opportunities
  - Additional community interaction and feedback provided by presenting initial science ideas at multiple major meetings
- SWP incorporated interdisciplinary scientific topics:
  - Encompass all relevant science communities and disciplines: planetary science, space science, life sciences, astrobiology, astronomy, physical sciences, etc.

# SWP: Science Enabled by Humans at a Deep Space Habitat in the Lunar Vicinity



- Lunar Surface Science using Telerobotics
  - Facilitate access to challenging regions by low-latency telerobotics (e.g. permanently shadowed crater floors)
  - Set up surface instrumentation
- Human-assisted lunar sample return
  - Increased return through more and improved selection of lunar samples
  - Only need to get samples to the Deep Space Habitat, not all the way to Earth. They are returned with the crew in the Orion
- Staging post for human/robotic missions
  - Could provide repeat access with a reusable lander
  - Can act as a fuel/maintenance depot
- Understand combined effects of radiation/fractional-gravity
- Additional Science Opportunities
  - Astronomical Observations
  - Fundamental Physics
  - Collecting Interplanetary Material
  - Heliophysics
  - Monitoring Earth's Climate
  - Deep Space Habitat as a Comm Relay
    - Enables government/commercial farside exploration
    - Lowers the bar for improved cubesat exploration



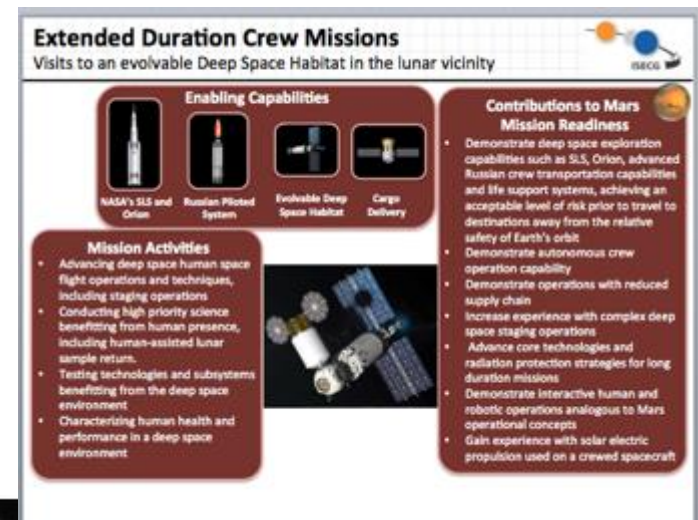
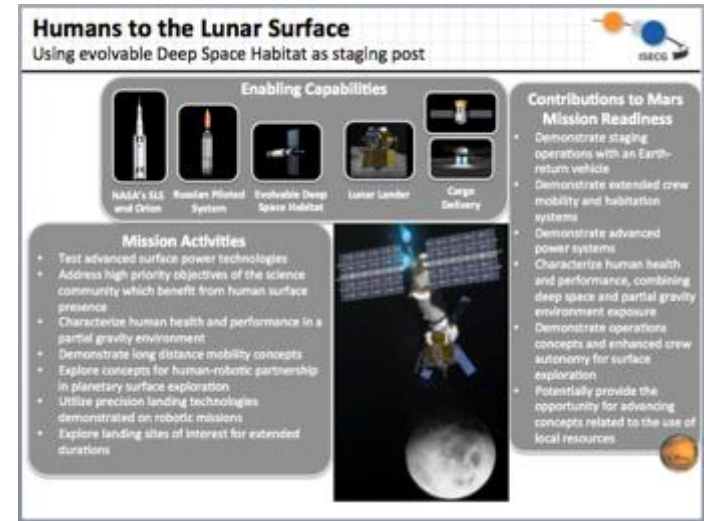
**The lunar vicinity may not be the “ideal” location for all types of science instruments, yet the presence of humans and their associated infrastructure provides opportunities can yield Decadal relevant science**



# SWP: Science Enabled by Human Exploration



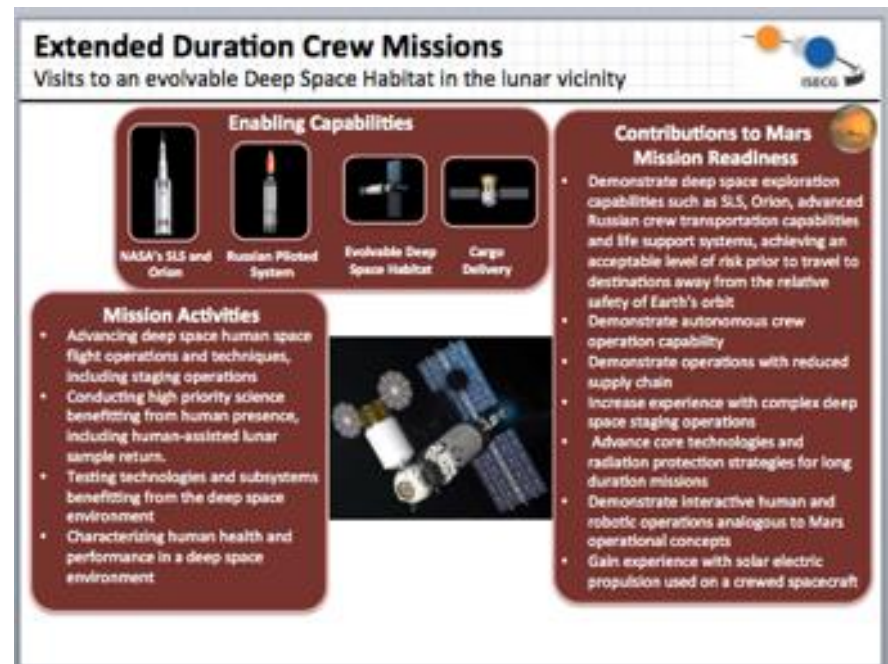
- The places where humans explore, such as a DSG in the lunar vicinity, may not be the “ideal” locations for certain scientific investigations, yet the presence of humans and their associated infrastructure provides opportunities that can yield Decadal relevant science
- Human Exploration permits the emplacement of scientific instruments on a scale different from what scientists/engineers typically consider.
  - Less mass/power/volume constrained
  - DSG communications capabilities could relieve pressure for other orbital and surface assets
- The SWP did not assume any particular DSG design. The proposed science could be achieved with a NASA/International/Commercial design



# Deep Space Gateway Science Study



- We are proposing to conduct a study to determine in more detail what high-quality science can be conducted from a DSG, and what level of resources are required
  - Study would consist of NASA personnel from NASA centers as well as scientists from academia
- Revisit the SWP science from a broad NASA perspective
  - Consider what Decadal science can be achieved by research on a DSG
  - What SKGs can be closed
- Consider all relevant scientific disciplines
  - Astronomical Observations
  - Collecting Interplanetary Material
  - Heliophysics
  - Earth's Atmosphere
  - Fundamental Physics
  - DSG as a Communications Relay
    - Enable lunar cubesats
  - Lunar Surface Science Using Telerobotics
    - Roving or instrument setup
- Instrument Scope
  - Scale of resources that instruments need?
- Community Workshop Format



# Workshop Steering Committee



- Jointly sponsored by SMD and HEOMD
- Co-convened by NASA HQ, JSC, MSFC, and GSFC
- Steering Committee consists of the Executive Committee and a Science Advisory Group
- Steering committee includes discipline experts from centers, academia, and a representative from ESA
  - ESA organizing a similar European-focused workshop

Executive Committee	Science Advisory Group	
Ben Bussey (HQ/HEOMD)	Jake Bleacher (GSFC)	Ruthan Lewis (GSFC)
Sasha Marshak (GSFC)	Jack Burns (U. Co.)	Clive Neal (Notre Dame)
Michael New (HQ/SMD)	Brad Carpenter (HQ)	Debra Hurwitz Needham (MSFC)
Jim Spann (MSFC)	Caleb Fassett (MSFC)	Paul Neitzel (Georg. Tech.)
Eileen Stansbery (JSC)	Jennifer Fogarty (JSC)	Mike Ramsey (Uni. Pitt.)
	Barbara Giles (GSFC)	Julie Robinson (JSC)
<b>Executive Secretary</b>	Dana Hurley (JHU/APL)	Bobbie-Gail Swan (JSC)
Paul Niles (JSC)	Sam Lawrence (JSC)	James Carpenter (ESA)

# Next Steps



- Two Parallel Activities
  1. Provide first-order end member numbers of potential instrument resources to DSG engineers
  2. Plan early-2018 DSG instrument workshop



# Next Steps (1/2) DSG Resources



- Provide first-order end member numbers of potential instrument resources to DSG engineers
- These needed by September 2017 to potentially influence DSG design
- Instruments could either go on the power/propulsion bus, the habitation module, or the logistics module
  - Logistics module will have heliocentric disposal orbits
- Resources needed are:-
  - Mass/power/volume/data/crew-time/location/preferred orbit(s)

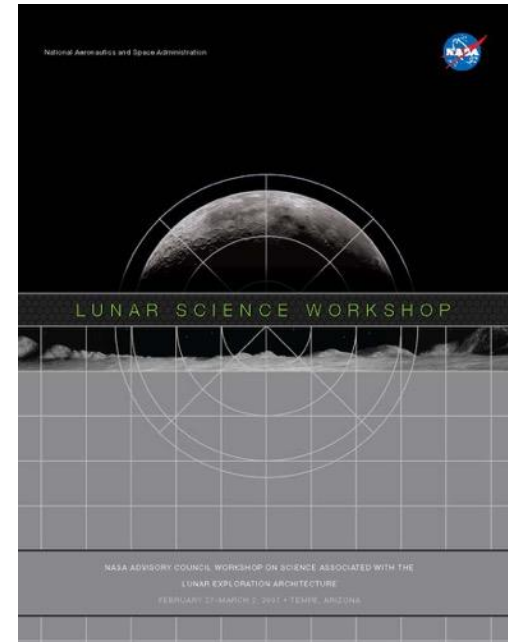
# Next Steps (2/2) DSG Instrument Workshop

- Plan early-2018 DSG instrument workshop
- First task of the steering committee is to identify how many parallel sessions the workshop should have and what disciplines are covered in each sessions
- First step is to identify ~4-5 potential session chairs
  - This list to be vetted by SMD division directors to ensure a breadth of experience
- From this group, select ~3 session chairs per session
  - These people will handle abstract review, put the detailed session together, and run the session

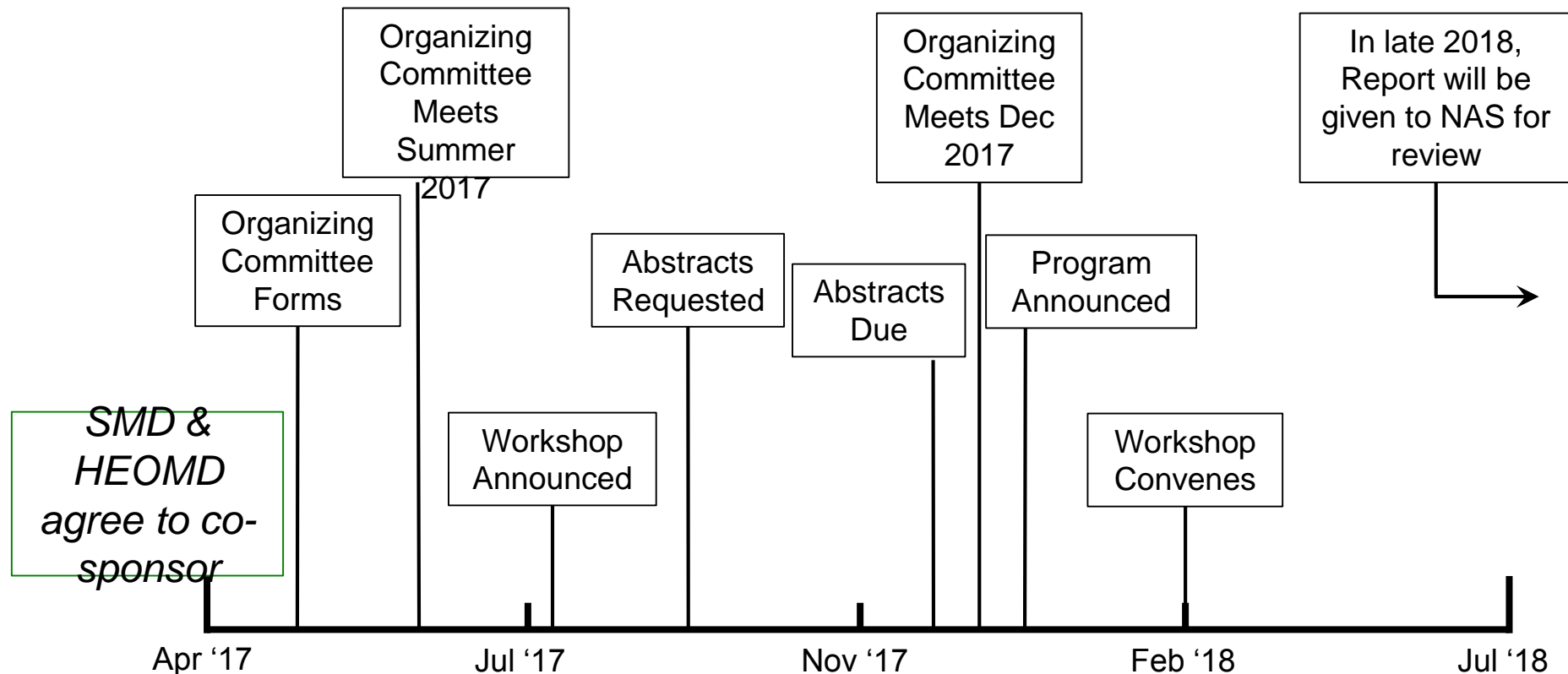
# Workshop Format



- Based on the successful Tempe Lunar Science Workshop held in 2007
- Attendance will be by invitation only based on an open call for presentations
  - Scientists, engineers, program managers, and decision/policy makers from NASA, academia, industry, and international organizations
- Two types of sessions: discipline-focused splinter sessions and final plenary
  - The bulk of the workshop will consist of parallel discipline-focused splinter sessions, during which potential science areas enabled by exploration are presented, discussed, and eventually synthesized to instrument concepts
  - Final day plenary session to summarize results and discuss the next strategic steps for how workshop content will be captured and disseminated



# Workshop Notional Schedule





# Expected Outcome and Significance



- A clear exposition of the possible Science opportunities, that are enabled by Human Exploration, over a broad range of disciplines beyond the established planetary science
- The identification of international collaborative concepts that could be pursued.
- The workshop products will have influence on
  - SMD as reflected in the upcoming Decadal Surveys
    - Shape of future instrument AOs
  - STMD as reflected in its investment areas and strategies in support of Agency science and exploration
  - HEOMD as reflected in the mission and program architecture to accommodate innovative and/or non-traditional science investigations
  - International collaboration strategies and concepts.