The Future of Space Operations

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AIAA SciTech

Office of Technology, Policy, and Strategy

The Future of Space Operations

Global Engagement

Global space economy reached $546 billion in 2022

Commercial growth reached $427.6 billion in 2022

Space Foundation, The Space Report 2023 Q2

Government and Commercial Owned

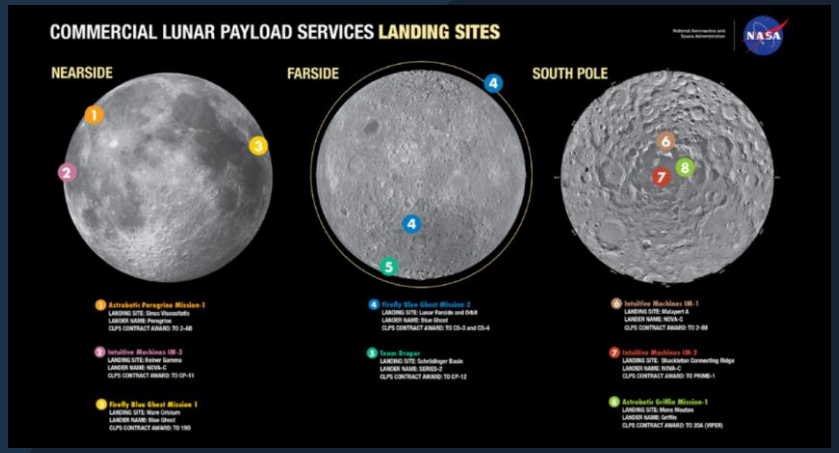

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Photo credits: NASA

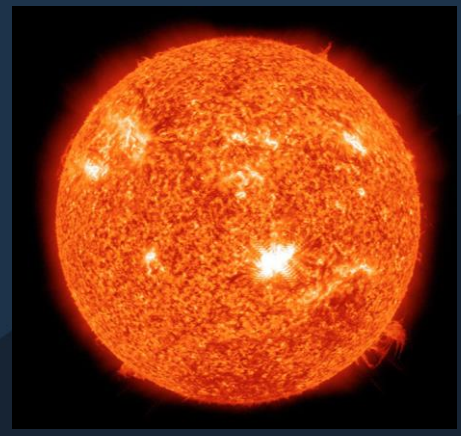
The “How” is Important

Explore, Discover, and Expand Knowledge for the Benefit of Humanity

Human Exploration, Technology, and Science

NASA’s Artemis I Mission

NASA’s ILLUMA-T payload communicating with LCRD over laser signals



NASA’s Solar Dynamics Observatory

- How to make decisions on new approaches?
- How to consider policy implications from technical decisions?
- How to consider ethical, legal, and societal implications?

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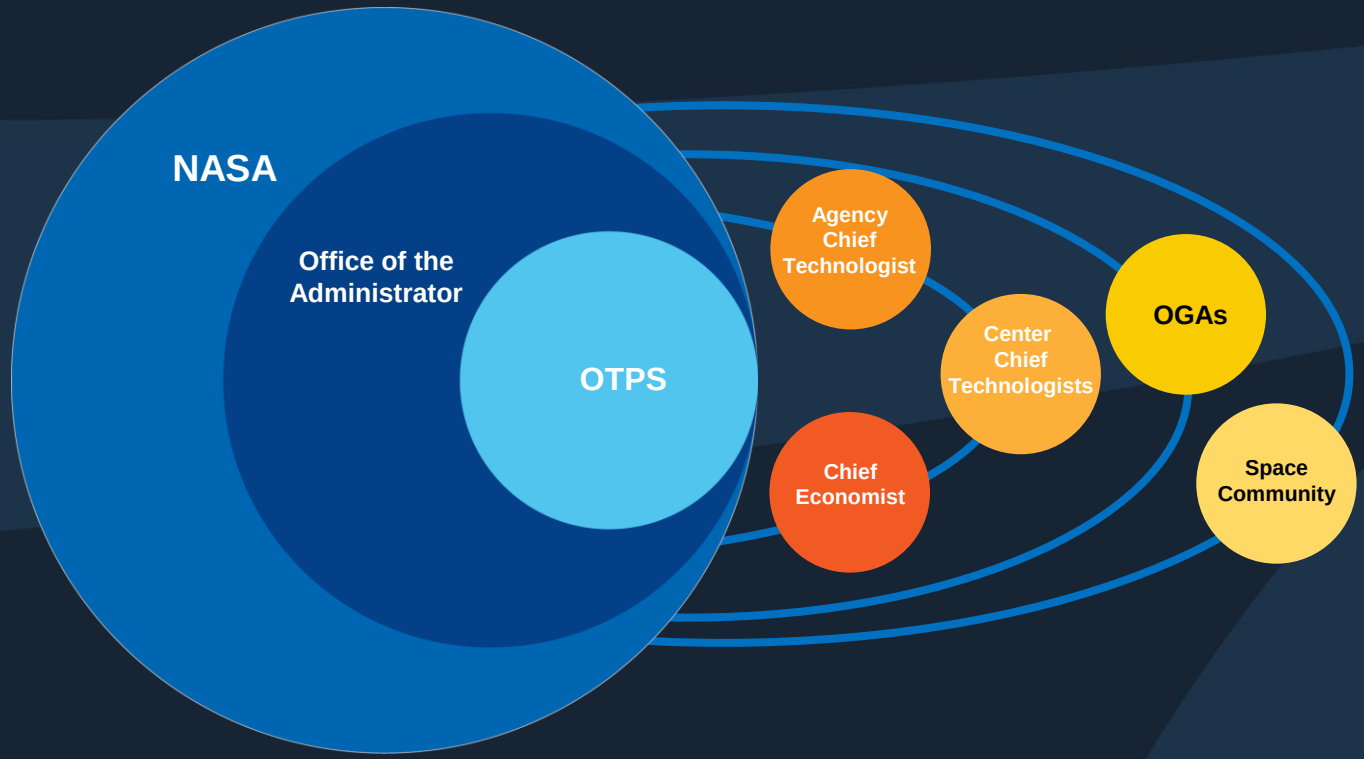
Photo credits: NASA

About OTPS

NASA's Office of Technology, Policy, and Strategy



- VISION: Preeminent analytical organization at NASA dedicated to best positioning the agency for the future
- MISSION: Provide assessments of internal and external drivers and technological advances so that NASA leadership can make informed policy choices and strategic decisions on behalf of the entire agency
- HOW: Work transparently with stakeholders across NASA, the Federal government, and the broader space community to answer pressing questions that are aligned with strategic priorities

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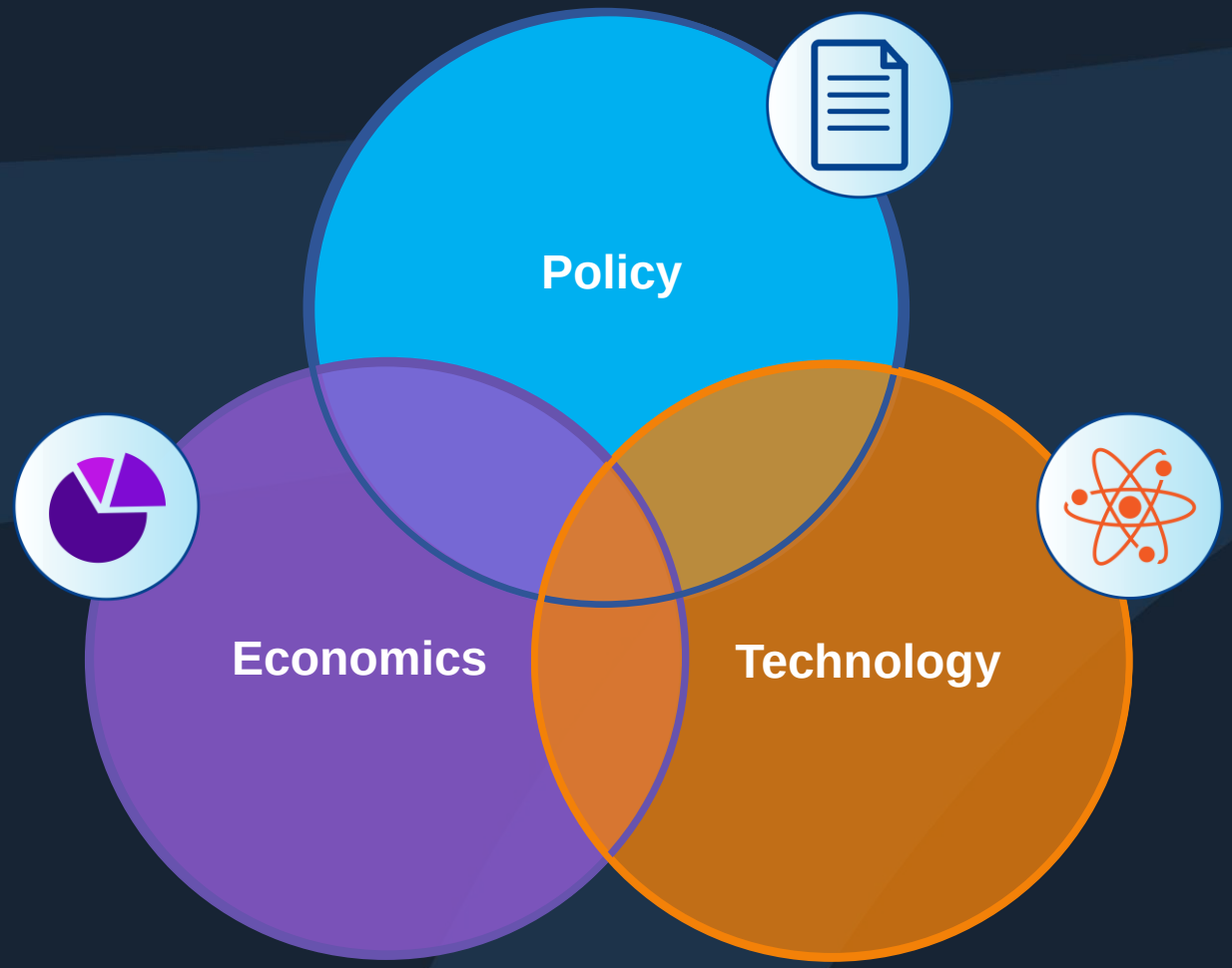
Multidisciplinary Analytical Approach



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Moon to Mars

OTPS explores emerging technologies to enable future NASA missions and helps establish norms of behavior for all those who seek to explore.

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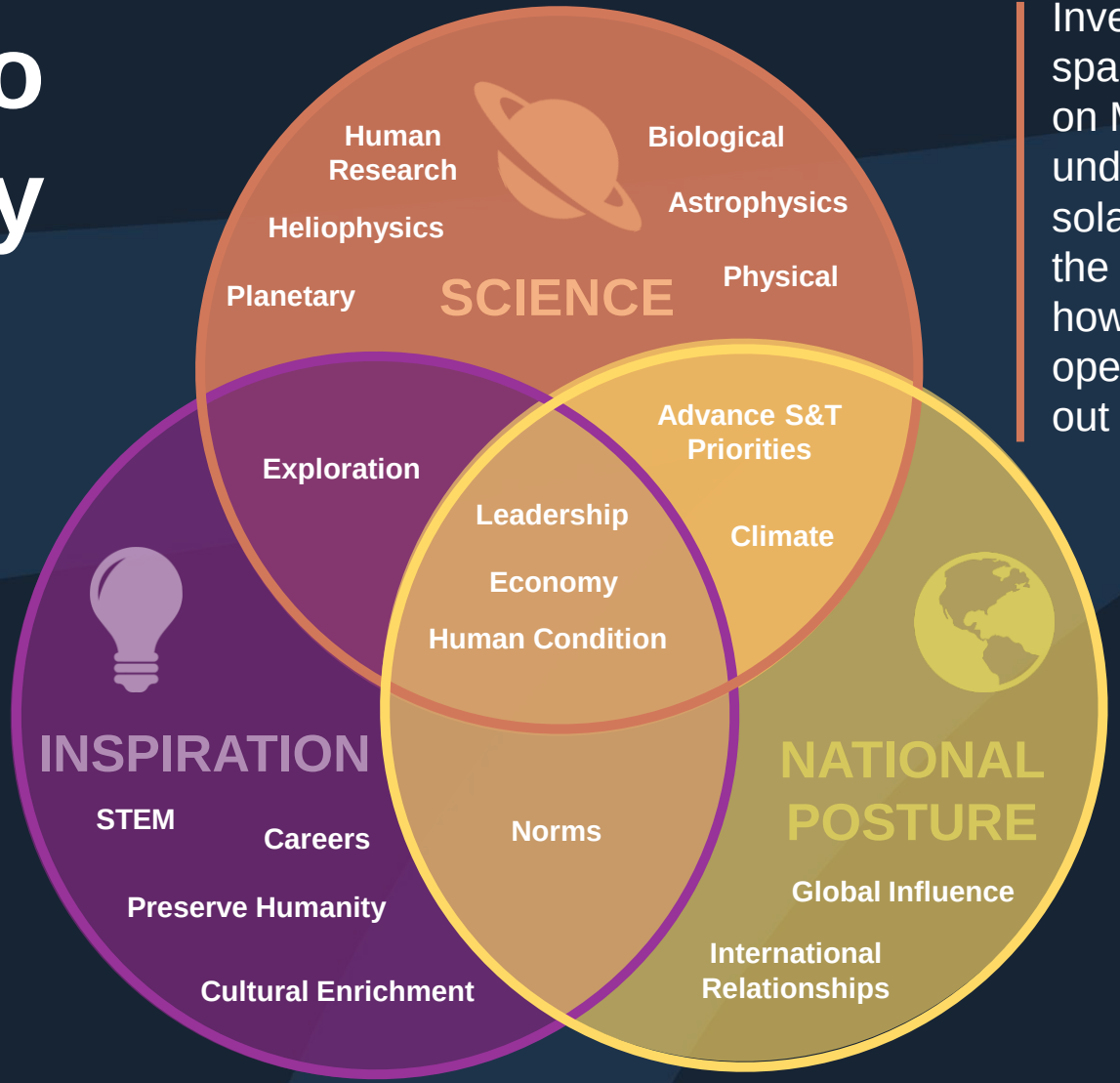
M2M Objectives: Why Go?

Benefits to Humanity



Investigations in deep space, on the Moon, and on Mars will enhance our understanding of the solar system, the Earth, the human body, and how to perform new operations while we are out there exploring.

Accepting audacious challenges and succeeding through perseverance and tenacity in the face of adversity motivates current and future generations to dare mighty things.

What we choose to do, how we do those things, and who we do them with greatly impacts our place in the world today, our quality of life, and our possibilities for the future.

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Policy Questions Framework

12 policy questions based on the M2M Objectives that can be used as a framework for future science and exploration missions

"policy questions" refers to the potential impacts, in the broadest sense, to NASA, national, or international space community interests

M2M Objectives [1]

- Science
- Infrastructure
- Transportation & Habitation
- Operations

Policy Questions

Sustainable Development	Interference Avoidance Among Actors
Role of NASA and Partners	Human Heritage
Protection of Valuable Locations	Effect on Earth by Operations
Planetary Protection	Cultural and Ethical Implications
Level of Transparency	Crew Safety Risk Posture
Interoperability and Standards	Benefit to All Humanity

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[1] NASA's Moon to Mars Strategy and Objectives Development, 2023

Released January 10, 2024

Moon to Mars

Lunar Landing and Operations Policy Analysis Report

- Addresses technical and policy considerations NASA should account for when:
  - Selecting lunar landing and operations sites
  - Implementing tools to protect operations and U.S. interest
- Provides options and recommendations to address seven identified challenges to lunar operations potentially mitigated by policy measures.

Artemis, Ethics and Society: Synthesis from a Workshop

- Experts from fields spanning social science, humanities, science and engineering discussed:
  - Ethical challenges of spaceflight
  - The handling of ethical, legal, and societal implications by other scientific endeavors with potentially profound societal effects.
- NASA's first structured look at future societal considerations since Apollo.

Policy Questions Framework

- 12 broad policy questions based on the M2M Objectives that can be used as a framework for future science and exploration missions:
  - To be used early in a program or project's lifecycle to help mission directorate leadership, program managers, and mission teams think through potential policy questions.
- To be used by the NASA, US, and international space communities to minimize negative impacts while maximizing positive ones

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Space Sustainability

OTPS conducts projects and enables external research on humanity's long-term ability to utilize space for science, exploration, national security, and commercial activities.

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Photo credit: NASA

Space Sustainability

Cost and Benefit Analysis of Orbital Debris Remediation

- The OTPS report studies removal and non-removal remediation approaches such as moving, removing, or reusing debris depending on its size.
  - Debris 1cm in diameter – largest junk
- OTPS model estimated the risks of debris strikes to spacecraft operators and how risks may be reduced by debris removal.
- Reframes the remediation benefits discussion to focus on reducing financial costs to satellite operators in the near-term.
  - Potential for greater benefits than costs in < 10 years

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Photo credit: NASA

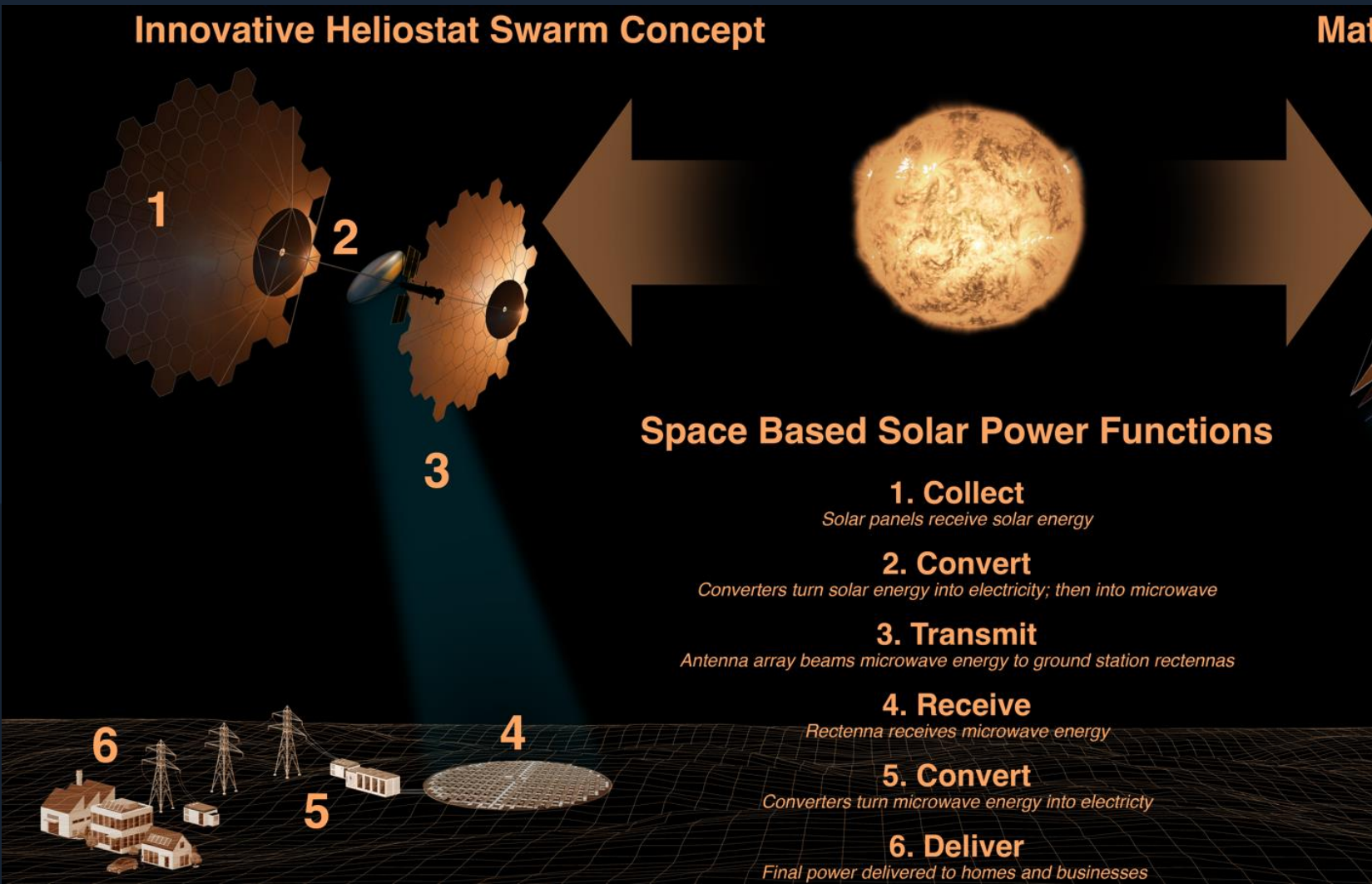
Technology Disruption

OTPS examines trends across NASA, domestic and foreign government partners, and industry to help the agency understand technology now, jump-start new, and champion infusion into the next missions.

Photo credit: Teresa Johnson/NASA

Space Based Solar Power in 2050

First-Order Lifecycle Assessment to Generate Electricity from Space Based Solar Power



COST
12-80 times more expensive than renewables

EMISSIONS
Similar emissions to renewables

Can reduce cost and reduce emissions with launch and manufacturing improvements

Released January 11, 2024

Questions?

Visit NASA OTPS

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