Fostering Scalable, Resilient Utility Infrastructure for Cislunar Space

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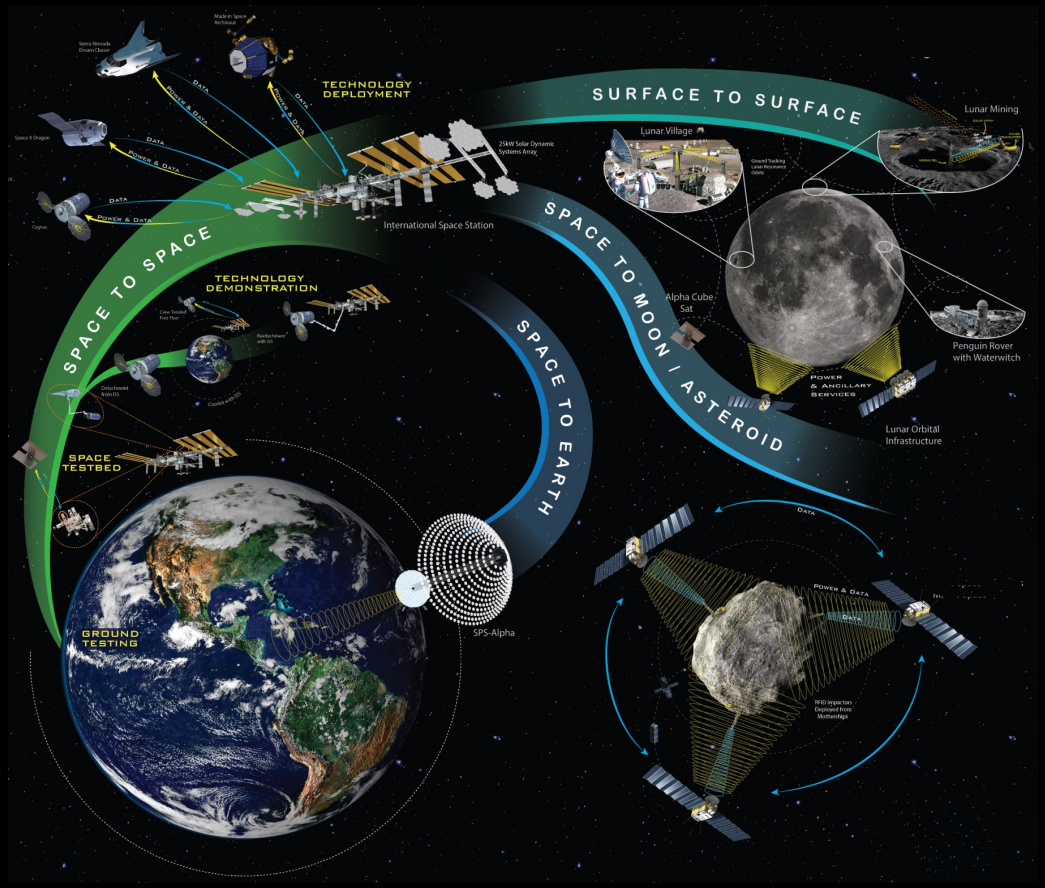
Space Development Foundation (SDF)

- **SDF Entity:** a USA based 501 (c) (3) tax exempt non-profit organization
- **SDF Focus:** advocating, orchestrating, and assisting in the fostering of space development in earnest.
- **SDF Objective:** enable initiatives directly and/or indirectly by providing critical support when needed to foster cooperative actions furthering space development.
- **SDF Funding:** provided by Xtraordinary Innovative Space Partnerships, Inc (XISP-Inc) and other XISP-Inc Technology Development, Demonstration, and Deployment (TD^3) Mission Development Consortium participants.

Image Credit: Rick Guidice / NASA

SDF Primary Threads for Strategic Action

- **Space Solar Power Realization**
  - Power & Ancillary Services Beaming
- **Tech Dev Mission Enablement**
  - Alpha Cube Sat
- **Cislunar and Beyond Ancillary Services**
  - Interoperable Network Communication Architectures
- **Advanced Automation & Robotics Evolution**
  - Management Operations Control Applications
- **Advanced Propulsion Strategies**
  - Halfway To Anywhere



Orchestrating Technology Development, Demonstration, and Deployment

Understanding the Problem/Solution Space

- **What you can learn to do really does matter . . .**
  - *Space development provides humanity options which we otherwise would not have*
- **Why your doing it can matter just as much if not more . . .**
  - *The consequences of extinction level events are irreconcilable.*
  - *Bringing new sustainable resources (energy, materials, and habitable area) to the table for use in space and on Earth for the dramatic betterment of humanity provides options for a positive future.*
  - *Understanding how to build and maintain viable, and sustainable space settlements is a microcosm of providing for all life as we know it.*

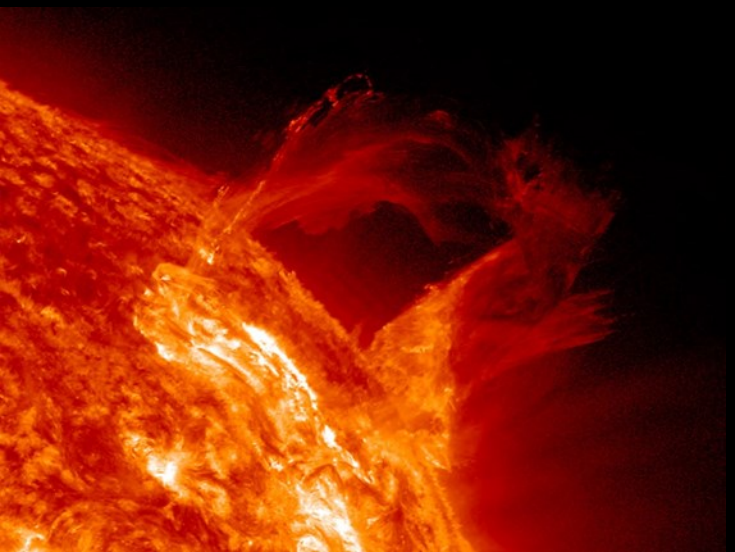
TD^3 Missions

- **Technology Development**
  - *Spans the spectrum from research sandboxes to applications engineering*
- **Technology Demonstration**
  - *Spans the spectrum from spectacle to practical tests of fitness for purpose*
- **Technology Deployment**
  - *Spans the spectrum from supporting the first users of a service to fielding scalable, resilient, sustainable utility infrastructure*

Effective TD^3 mission development entails combining technology "push" and mission requirements "pull" to realize new capabilities.

Mission Development Matters

- **Successful TD^3 missions:**
  - Need to be *biased towards success* by design
  - Define both the *problem and solution spaces*
  - Integrate *iterative* trials and *recursive* spirals
  - Foster *cooperation, collaboration, and* allow for *competition*
  - Provide a means to *clarify expectations* based on *articulated interests* and shared *understanding of the follow-through*

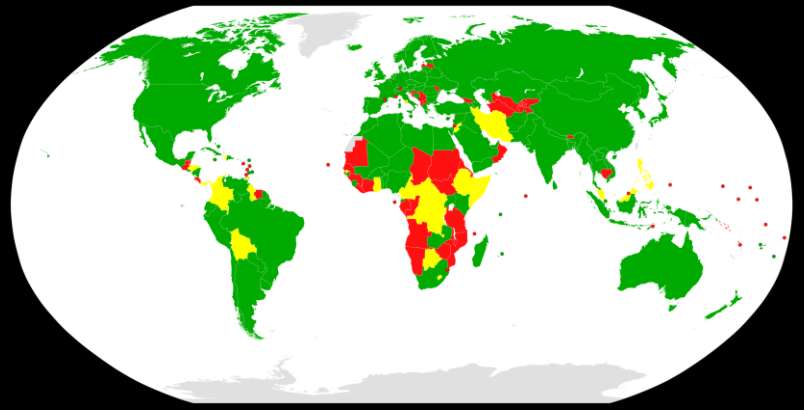


If you do not know where you are trying to go and why . . .
it is a whole lot harder to get there!

OUTCOMES MATTER

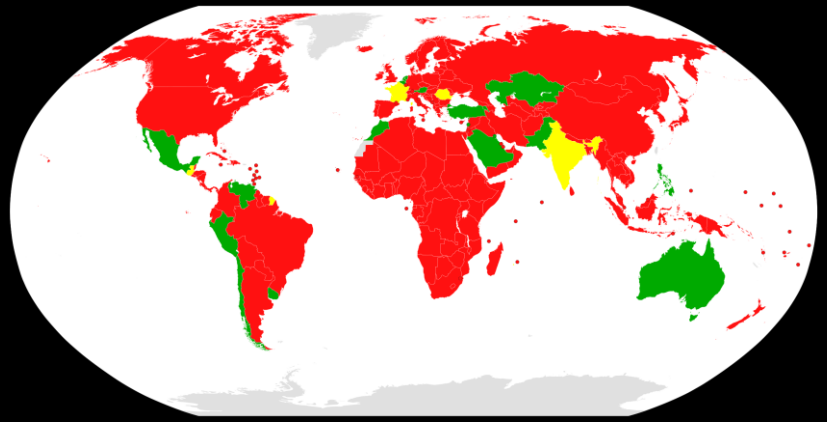
- *Efforts in statecraft that are based on a confluence of interests that are clearly defined tend to be widely ratified/adopted*
  - *1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.*
  - *ratified by all states that engage in self-launched human spaceflight or have plans to do so.*
    - Number of Parties: 107 Number of Signatories: 89
- *Efforts in statecraft that are based on aspirations without a foundation of clearly articulated interests tend to flounder*
  - *1979 Moon Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*
  - *not ratified by any state that engages in self-launched human spaceflight or has plans to do so.*
    - Number of Parties: 18 Number of Signatories: 11
- *Accordingly, lending our efforts to drawing out, articulating, and affirming confluences of interests where they can be found seems the most prudent and logical course of action.*

1967 Treaty



Parties Signatories Non-parties

1979 Moon Agreement



OPPORTUNITIES – Fostering Better Outcomes

Scalable, resilient utility infrastructure for Cislunar space is realizable for:

- *Interoperable Network Communications Architectures (INCA)*
  - *Pervasively Networked Quality of Service (QoS) based Communications*
  - *Cislunar Spatial Positioning & Navigation Markers and Beacons*
  - *Unified Time Base*
- *Space Solar Power and ancillary services Beaming (SSPB)*
  - *Power when and where it is needed across multiple venues*
  - *Space-to-space, Surface-to-surface, Space-to-Moon/Asteroid surface, Space-to-Earth*
- *Management Operations Control Applications (MOCA)*
  - *Autonomous Navigation*
  - *Situational Awareness*
  - *Orbital Debris Mitigation & Remediation*
  - *Shared human, robotic, and autonoma control*

OPPORTUNITIES – Fostering Better Outcomes

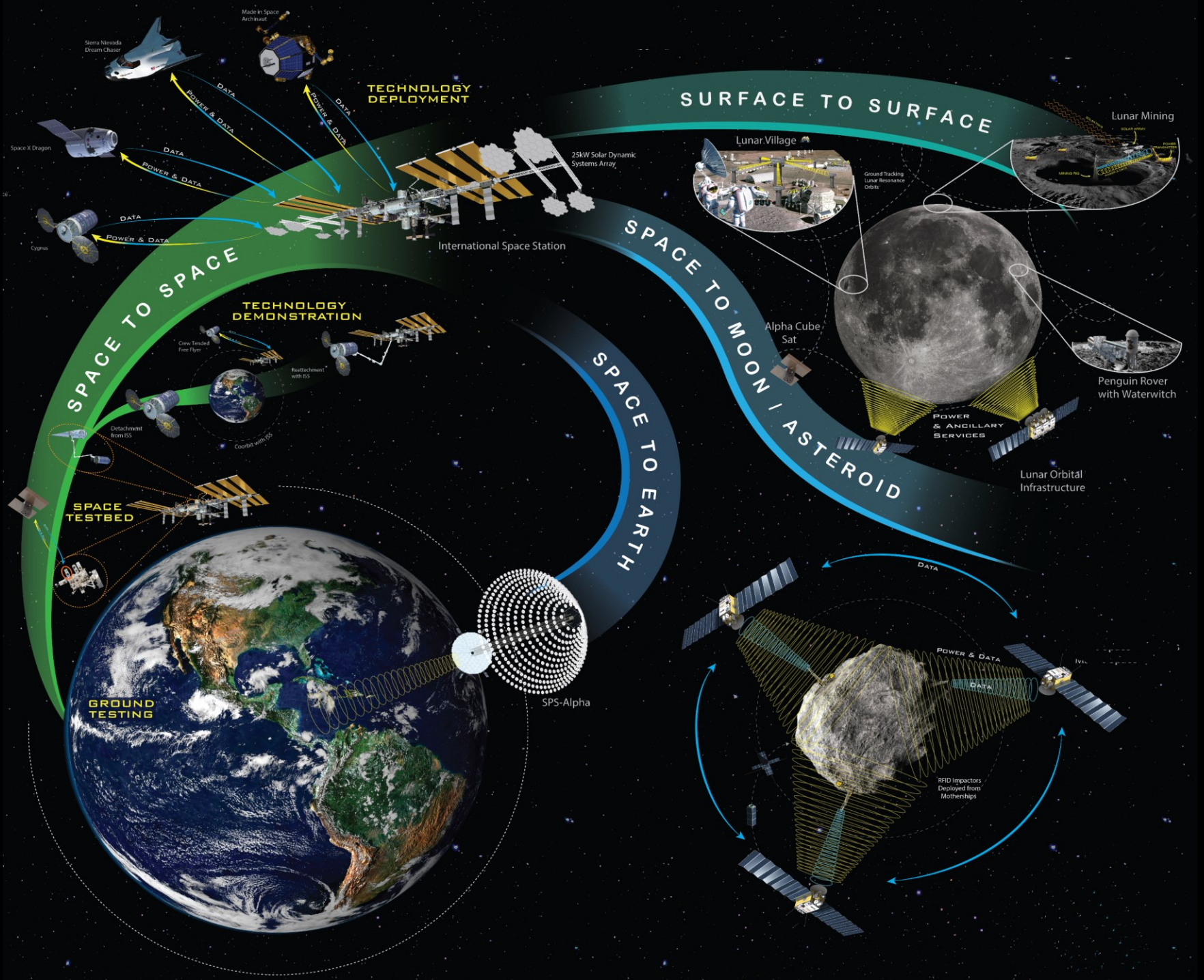
- *Alpha Cube Sat (ACS)*
  - *Early TD^3 flight opportunity model*
  - *Economies of scale foster cost effect rapid path to flight missions*
  - *Synergistic technology development, science, and commercial payload accommodations*
  - *Electro-optical Interferometry*
- *Halfway To Anywhere (HTA)*
  - *Advanced H_2O based propulsion systems using the states of matter (i.e., solid, liquid, gas, plasma) appropriate to the application*
  - *Alternate Minimum Energy Trajectories*
  - *Ground Tracking Long Term Stable Lunar Resonance Orbits*

OPPORTUNITIES – Fostering Better Outcomes

- Capital Infrastructure
  enables more economical satellite and science operations in space
  - Satellite servicing and repair
  - Fuel depots
  - Standardized rendezvous and docking hardware
- Commodities Infrastructure
  enables practical and sustainable human activities in space
  - Air and water production from asteroid and lunar resources
  - Agriculture and food production
  - Recycling systems
  - Commodities production for daily living, e.g., clothing, cleaning products, and personal hygiene (toilet paper, toothpaste, …)
- And a myriad more . . .

TD³ missions can foster scalable, resilient utility infrastructure for Cislunar space

Flows of People, Material, Energy & Information



Art Credit: Aaron Cohen, © XISP-Inc 2019

Next Steps

- ***Interoperable Network Communication Architectures (INCA)***
  Support the cooperative orchestration of interoperability practices and standards.
- ***Space Solar Power and ancillary services Beaming (SSPB)***
  Support early TD³ missions to enable technology across all venues
- ***Management Operations Control Applications (MOCA)***
  Draw out the confluence of interests necessary to support virtualized functions and services in realizable infrastructure.
- ***Alpha Cube Sat (ACS)***
  Foster the use of affordable spacecraft systems as enabling modular TD³ infrastructure.
- ***Halfway To Anywhere (HTA)***
  Foster the enablement of Cislunar logistics infrastructure.

Art Credit: NASA, et al.

Art Credit NASA

Space is our future . . .

Let's not wait for it, let's build it!

http://spacedevelopmentfoundation.org