# SSP-2019 Introduction

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# Space Power Beaming & Ancillary Services

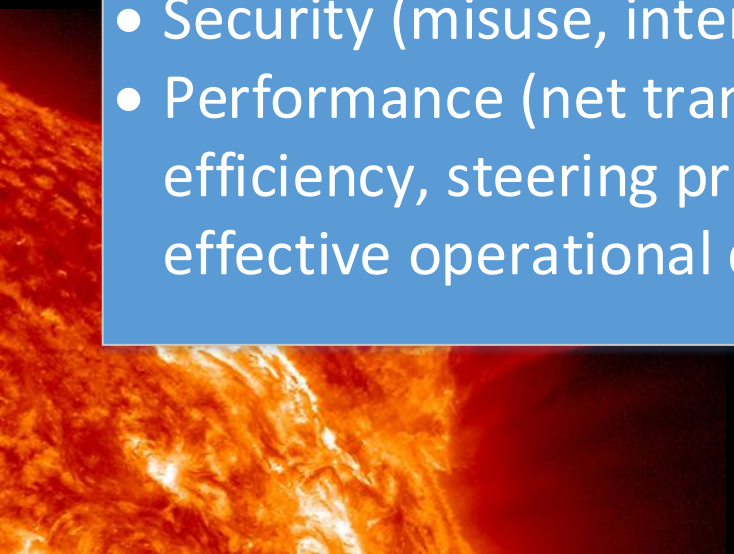
(1) Key Considerations
(2) Key Variables
(3) The Challenge Matrix
    - The Problem Space
        - Ground & Space Technology Development
    - Solution Space
        - Demonstration
        - Deployment
(4) Visualization
(5) XISP-Inc Space-to-Space Power Beaming Example
(6) Mission Technology, Development, and Demonstration $TD^3$

# Space Solar Power Key Considerations

- Space Solar Power is an applied engineering problem and an economics problem.
- Applications have significant systems engineering and economic challenges in each venue that must be successfully addressed.
- Each venue has different fundamental figures of merit which define their value proposition.
- Operational capabilities are best realized by leveraging a combination of technology development "Push" and mission requirements "Pull".
- Each increment of public and/or private investment should lead to an operational capability.
- Work Vectors: Technology Development → Demonstration → Deployment and Space-to-Space → Surface-to-Surface → Space-to-Alt Surface → Space-to-Earth

# Space Solar Power Key Variables

- Cost/Economics (initial cost to first power, LCOE, market viability, anchor customers),
- Frequency/Wavelength (microwave to eyesafe optical),
- Distance (near field, boundary regions, far field),
- Magnitude (i.e. power level supporting application)
- Duration (pulsed, scheduled, continuous),
- Availability (on demand, scheduled, prioritized, by exception),
- Security (misuse, interruption, destruction), and
- Performance (net transfer, end-to-end efficiency, piecewise efficiency, steering precision and accuracy, beam shaping, effective operational difference).




# Space Solar Power Problem Space

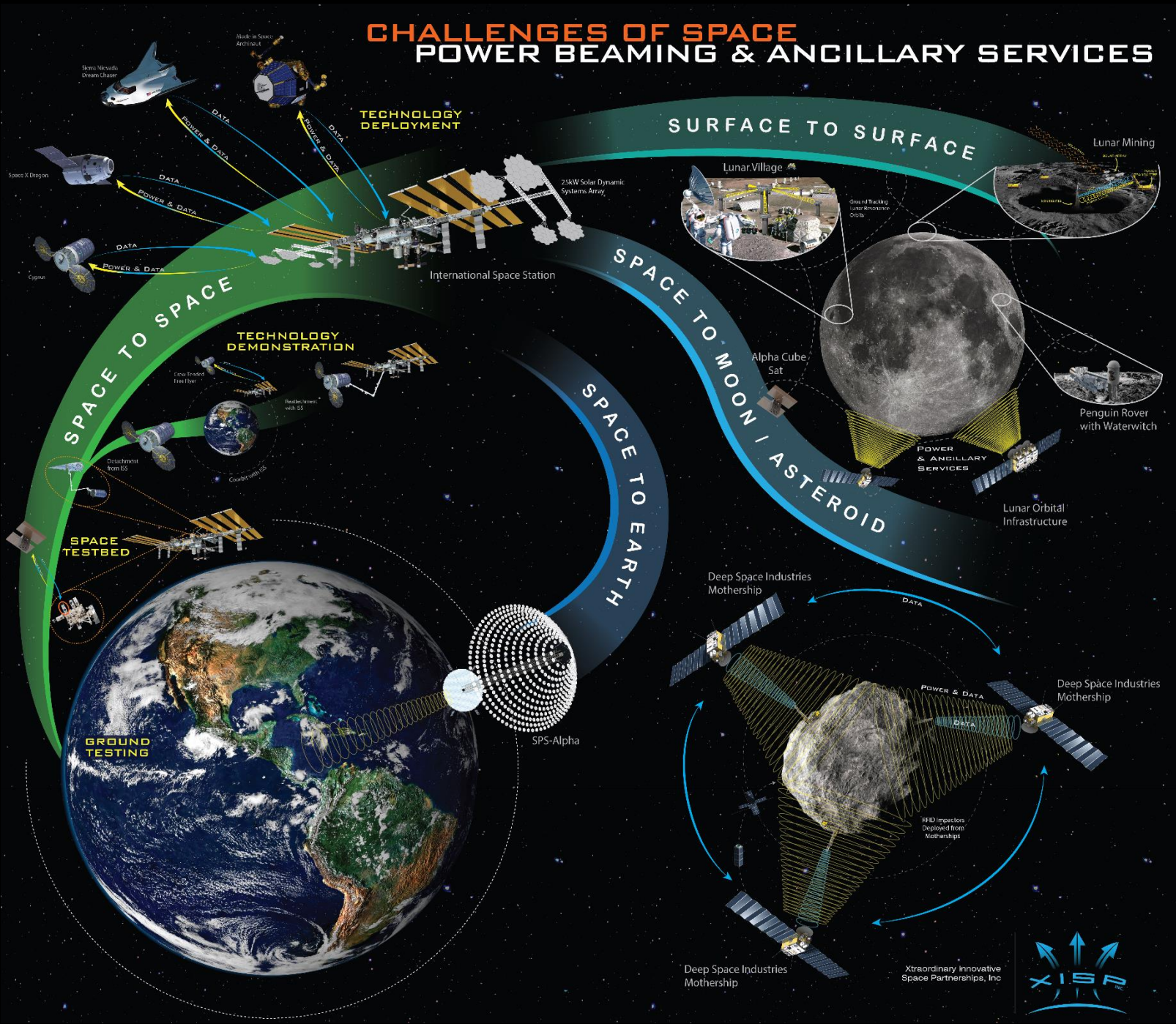
## Technology Development

| Venues | Ground | Space |
|---|---|---|
| Space - to - Space | • Cognitive SDR Transceiver<br>• Converged Electro/Optics<br>• W Band & Optical Apertures<br>• Piecewise Efficiency<br>• Reflectarray Rectenna<br>• Beam Forming<br>• Management Operations Control Applications (MOCA) | • ISS Mounted Transceiver<br>• Deployable Rectenna<br>• 6U Flight Test Article<br>• Optimized Frequencies<br>• End-to-End Efficiency<br>• Scaling/Modularity (Gen, Trans, and Control)<br>• Multiplexing Services<br>• MOCA S/W & Data System |
| Surface - to - Surface | • Deployable Power Generation & Relay Towers<br>• Conformal Rectenna<br>• Deployable Rectenna<br>• Solar Concentrator/Reflector | • Powered Rover<br>• Powered Prospector<br>• Powered Miner<br>• Volatile/Metal Separation |
| Space - to - Moon / Asteroid | • Disaggregatable Flight Systems Technology<br>• Scalable Transceiver<br>• Scalable/Printable Rectenna<br>• Management Operations Control Applications (MOCA) | • Mothership with deployable sensors/rovers<br>• Distributable Rectenna<br>• Lunar Resonant Orbits<br>• Beam Steering (Phased Array & Gimbals) |
| Space - to - Earth | • Lunar Resource Model<br>• Asteroidal Resource Model<br>• Drive launch costs down to $100/kg to LEO<br>• Atmospheric Transparency<br>• Beam Management -- Frequency/Control/Security<br>• MOCA Authentication, Authorization and Control System | • Modular Structure I/Fs (mechanical/robotic/ control/thermal)<br>• Thermal Management<br>• Pointing Large Structures<br>• Electro-Magnetic/Optical Alignment<br>• Solar Dynamic Modules<br>• Non-Iridium Based Concentrated Photovoltaic |

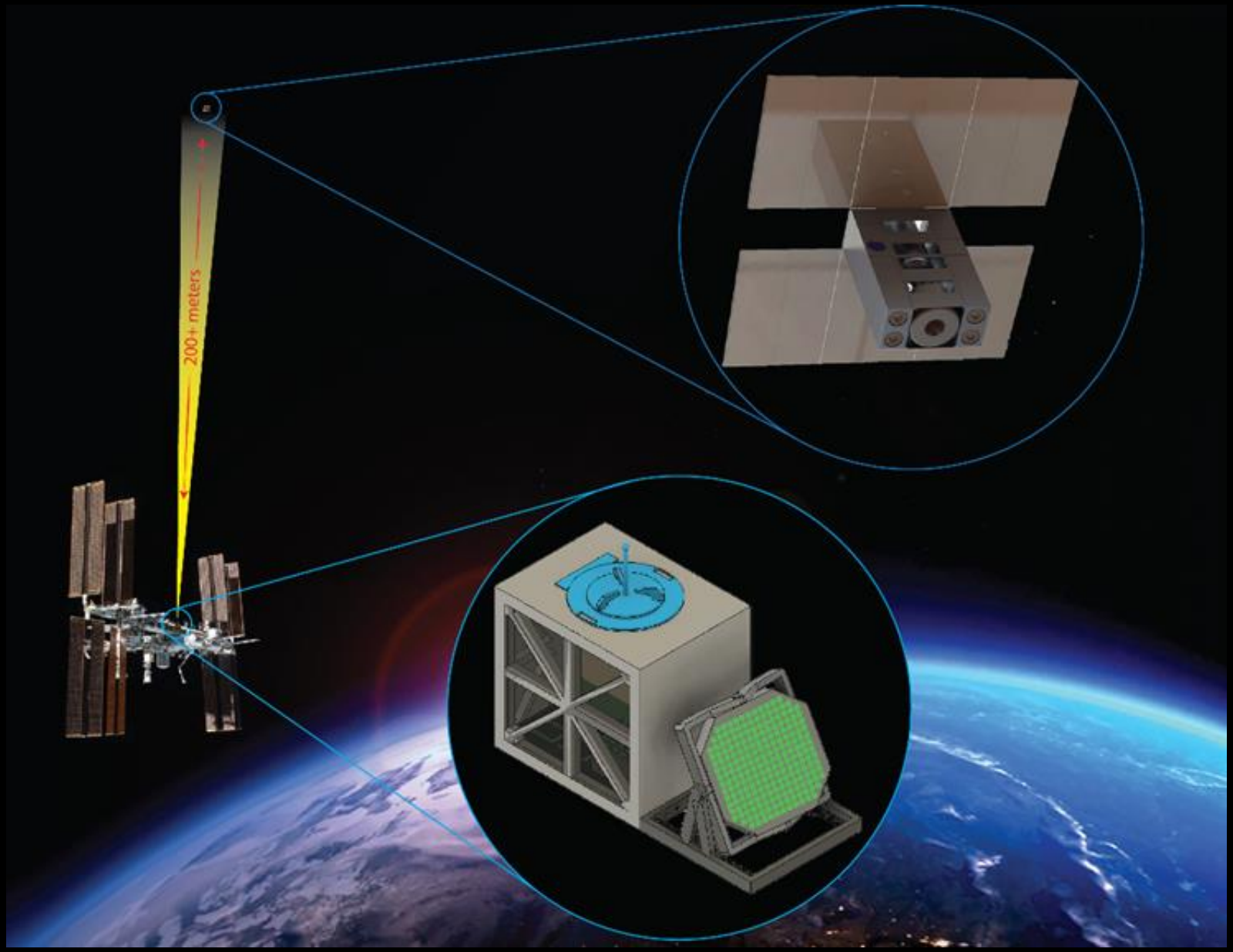
# Space Solar Power Solution Space

## Operational Capability/Applications

| Venues | Technology Demonstration | Technology Deployment |
|---|---|---|
| Space - to - Space | • ISS Co-orbiting Crew Tended Free Flyer Demo<br>• Propulsion Augment Demo<br>• Space Based Propellant Depot Operations Demo<br>• Disaggregated Formation Flying Spacecraft Demo<br>• Plug in/Plug Out Tech Demo | • Power & Ancillary Services Beaming Interface Kit(s)<br>• Dispatchable Power & Ancillary Services<br>• Cislunar Propulsion Services<br>• Kilowatt scale services |
| Surface - to - Surface | • Power & Ancillary Services Beaming - Survive the Night<br>• Volatiles Mining Demo<br>• Propellant Depot Demo<br>• Metals Mining Demo | • Dispatchable Power & Ancillary Services<br>• 24x7 Operations Support<br>• Kilowatt to Megawatt Scale Services |
| Space - to - Moon / Asteroid | • Power & Ancillary Services Beaming Demo<br>• Lunar Assay & Mining Demo<br>• Asteroidal Assay & Water/ Volatiles Mining Demo<br>• Asteroidal Optical Drilling, Volatiles Mining & Demo<br>• Metal Refining Demo<br>• Planetary Defense | • Synergistic impact of Cislunar Development<br>• Dispatchable Power & Ancillary Services<br>• 24x7 Operations Support<br>• Megawatt to Gigawatt Scale Services |
| Space - to - Earth | • Power & Ancillary Services Beaming to UAVs & Others<br>• Power & Ancillary Services Beaming to Forward Bases<br>• Power & Ancillary Services Beaming to Terrestrial Grid | • Synergistic impact of Cislunar Development<br>• Dispatchable Power & Ancillary Services<br>• National and International Geopolitical High Ground<br>• Gigawatt to Terawatt Scale Services |


CHALLENGES OF SPACE
POWER BEAMING & ANCILLARY SERVICES
TECHNOLOGY DEPLOYMENT
SURFACE TO SURFACE
SPACE TO SPACE
SPACE TO MOON / ASTEROID
SPACE TO EARTH
TECHNOLOGY DEMONSTRATION
SPACE TESTBED
GROUND TESTING
International Space Station
25kW Solar Dynamic Systems Array
Lunar Village
Lunar Mining
Alpha Cube Sat
Penguin Rover with Waterwitch
Power & Ancillary Services
Lunar Orbital Infrastructure
SPS-Alpha
Deep Space Industries Mothership
Deep Space Industries Mothership
Deep Space Industries Mothership
RFID Impactors Deployed from Motherships
Xtraordinary Innovative Space Partnerships, Inc
DATA
POWER & DATA

# SSPB Mission Overview



# XISP-Inc "Follow the Resources" Mission Development Diagram