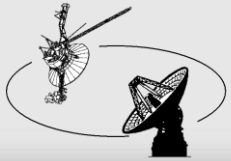

An Inter Planetary Network Enabled by SmallSats and Optical Communications

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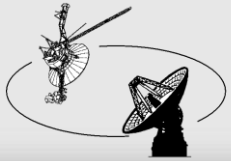
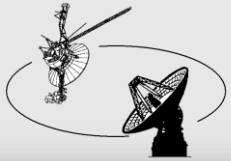


Outline

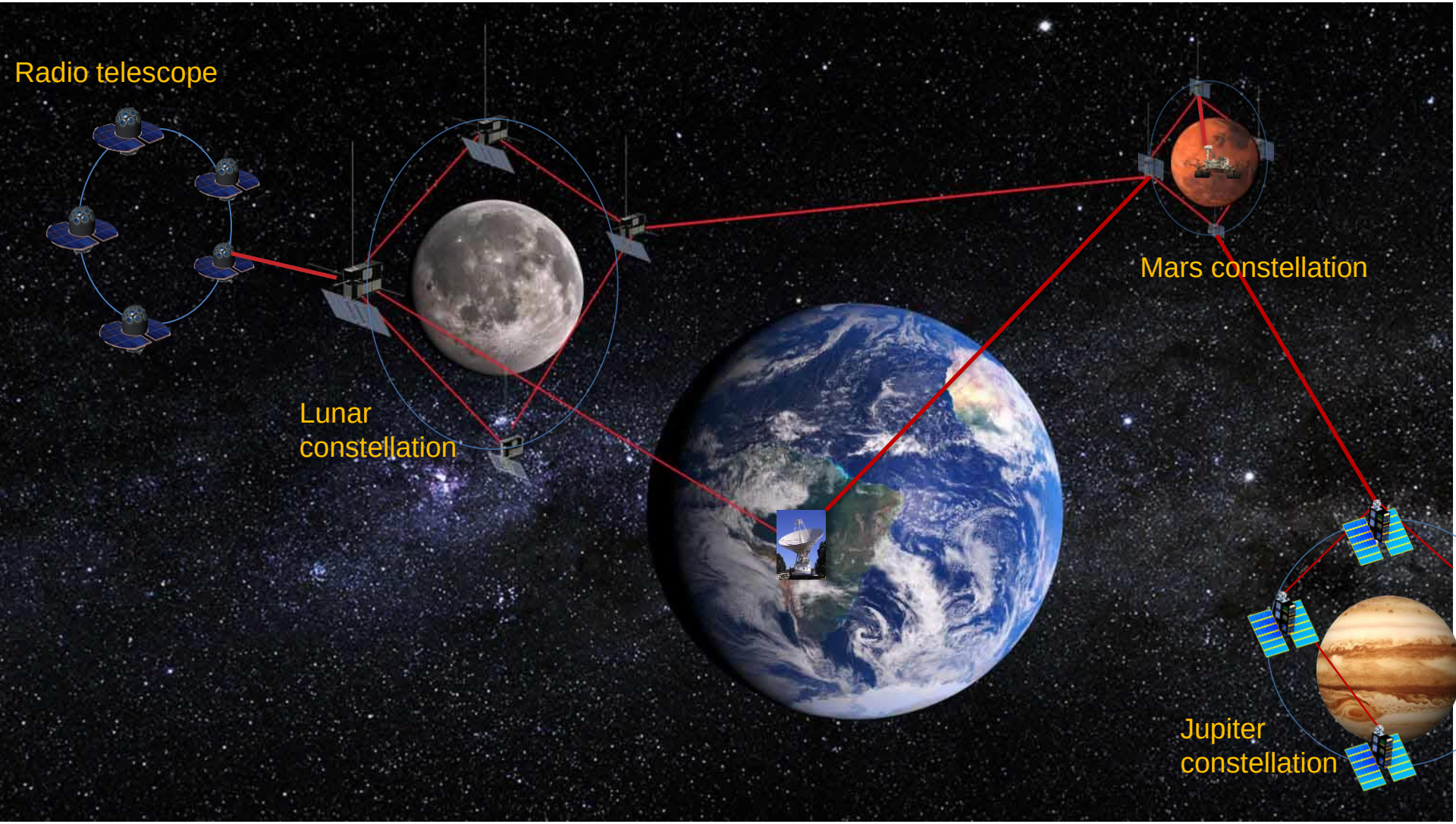
1. Introduction
2. IPN Arrangement
3. Technologies for IPN
4. IPN Implementation - Examples
5. Conclusions



1. Introduction

- We are proposing the Interplanetary Network (IPN)
- The IPN is a **space platform** composed of **thousands** of **small spacecraft** distributed along the **solar system**
- Each IPN spacecraft is furnished with **suitable sensors** and **communications systems**
- The **optical communications** system will allow the spacecraft to be part of the IPN using proper **protocols**
- The IPN also includes planetary landers, rovers, instruments
- The IPN will enable the **Internet of Things in space** exploration

1. Introduction

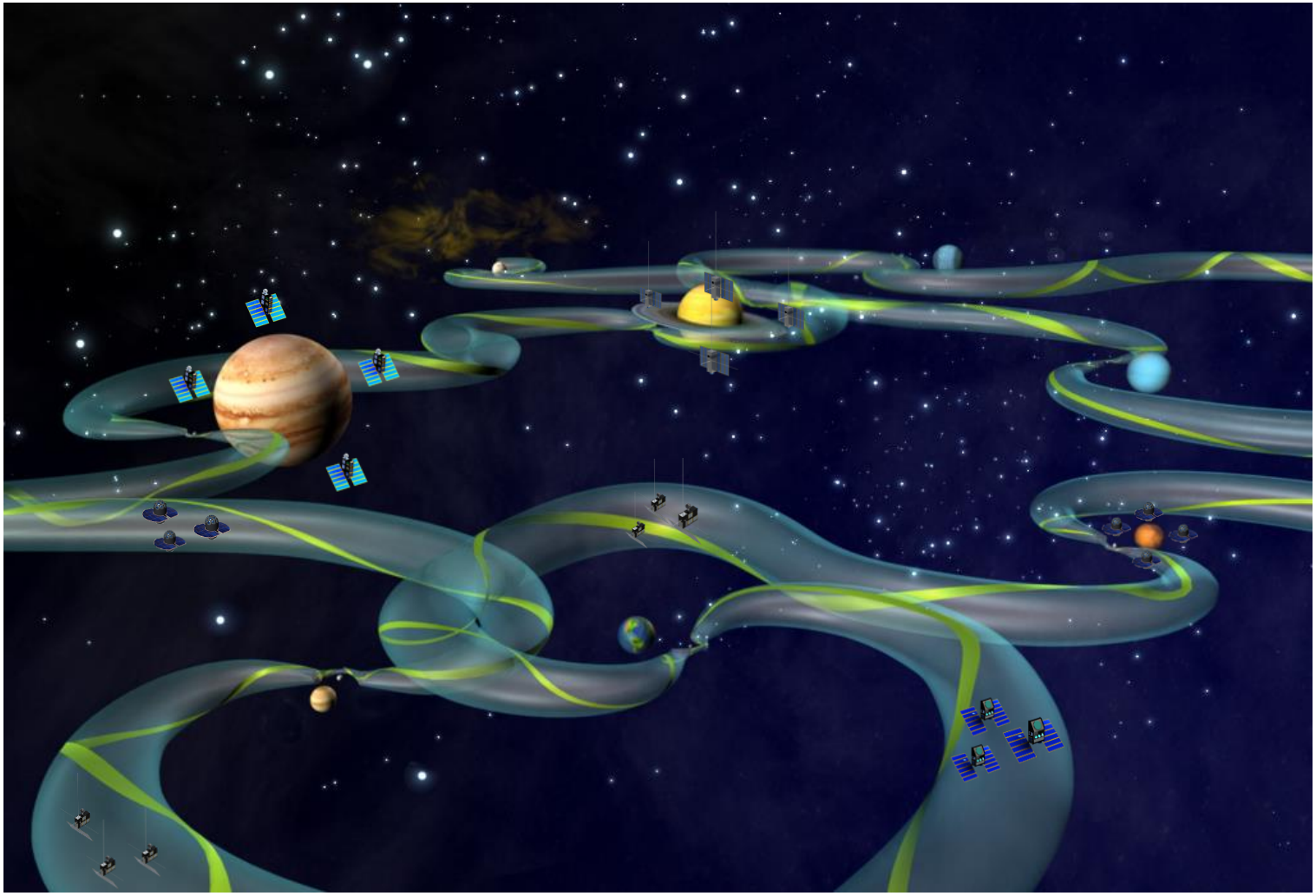


Proposed Inter Planetary Network

IPN

1. Introduction

The IPN will be enabled by the Interplanetary Superhighway

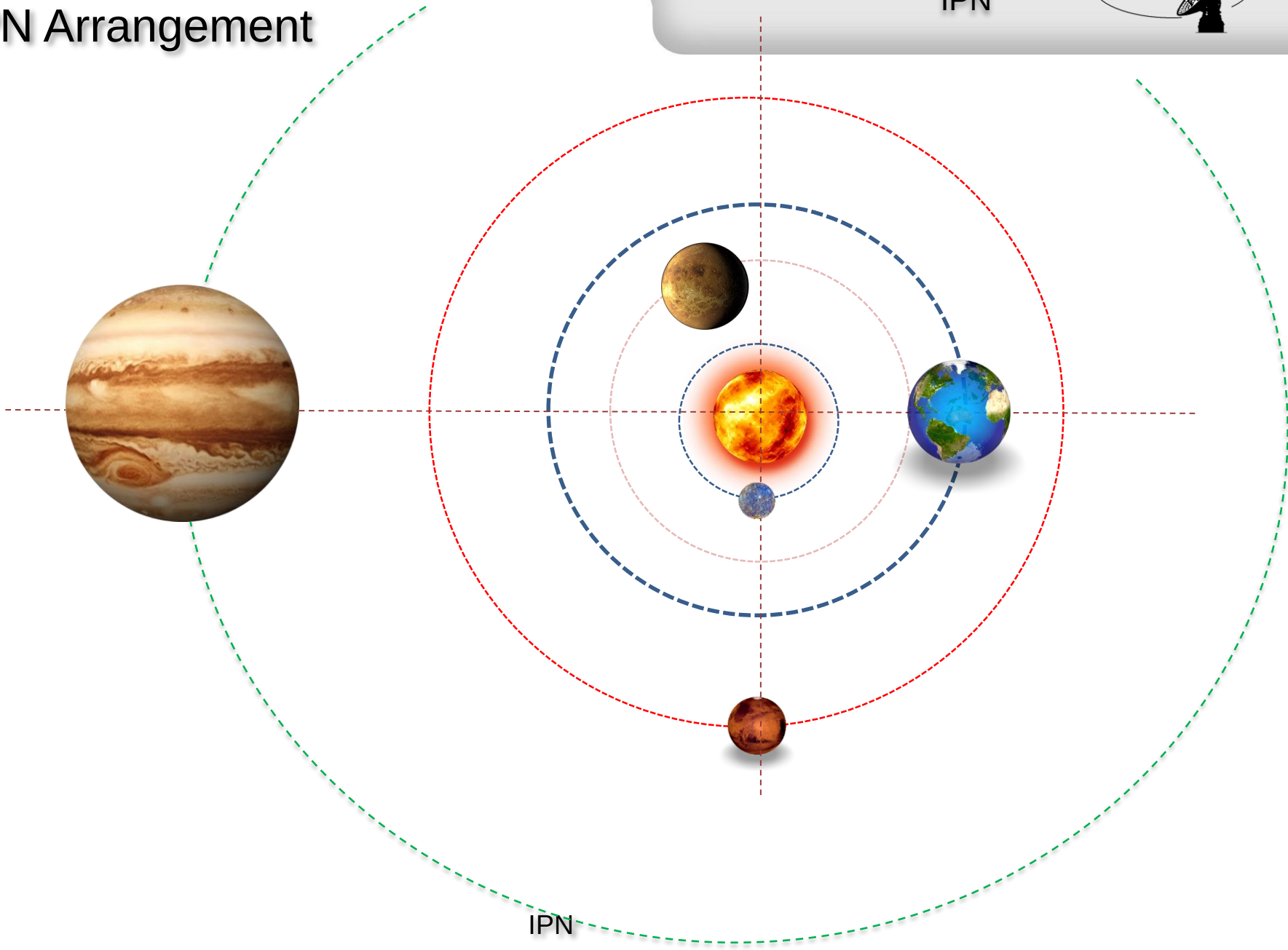


1. Introduction

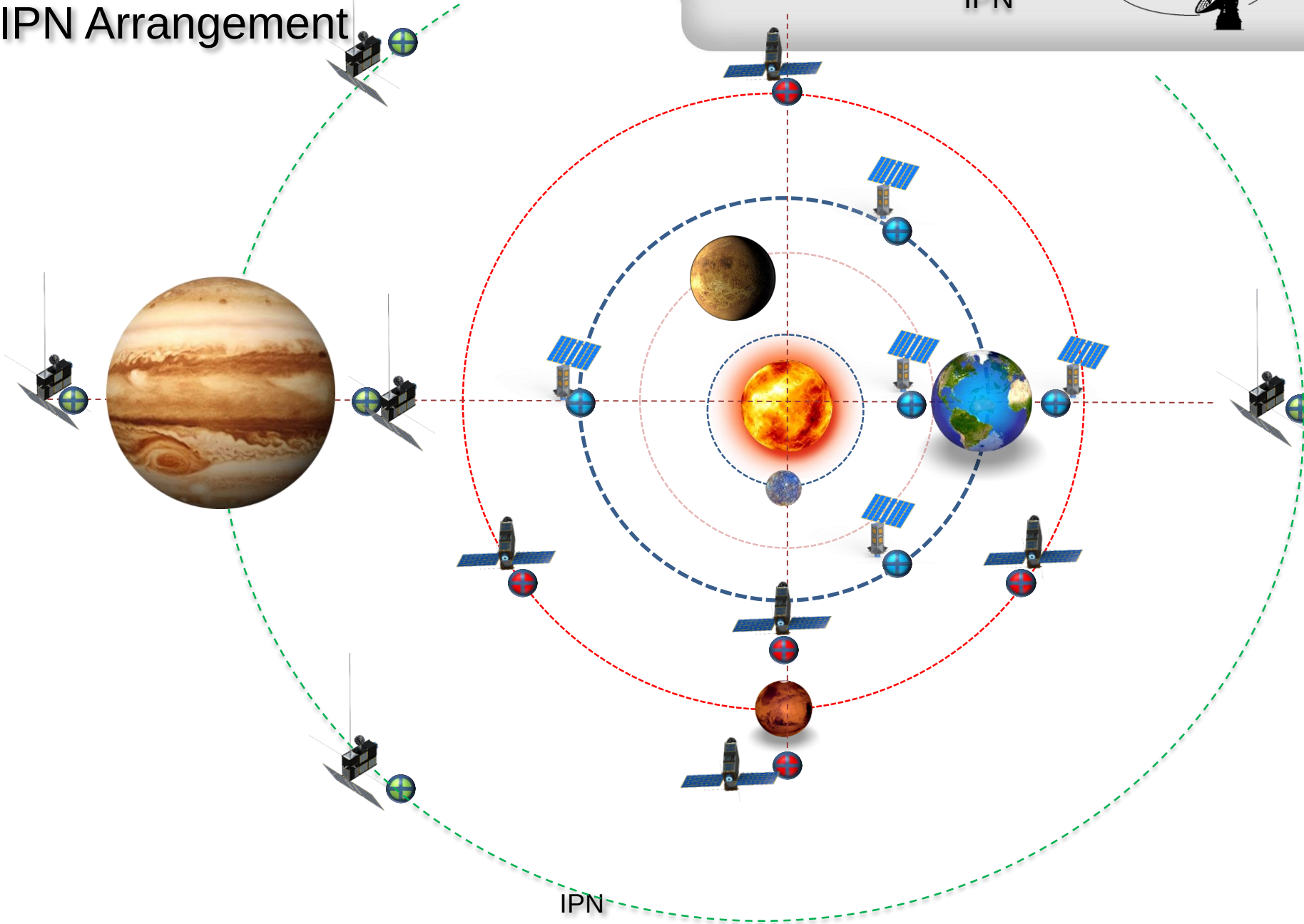
What is the Interplanetary Superhighway?

- The Interplanetary Superhighway is a collection of gravitationally determined pathways through the Solar System that require very little energy for an object to follow.
- The Interplanetary Superhighway makes particular use of Lagrange points as locations where trajectories through space are redirected using little or no energy.

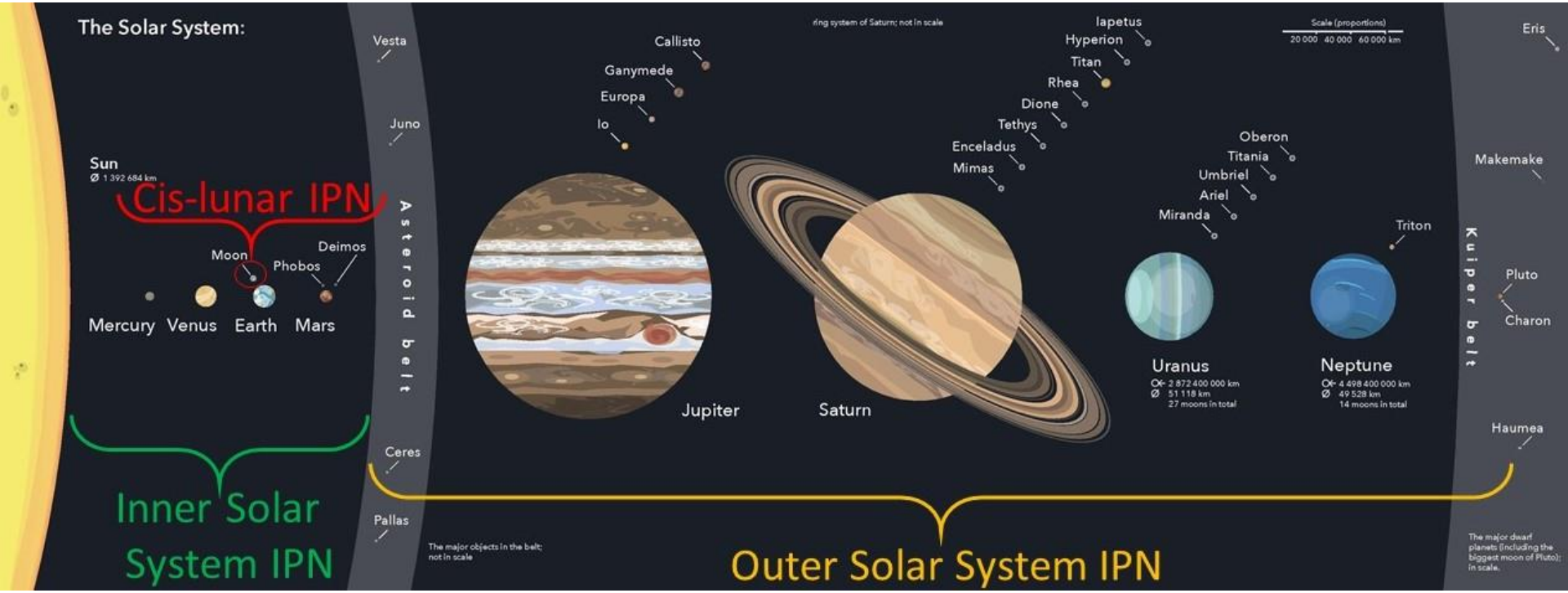
2. IPN Arrangement



2. IPN Arrangement



2. IPN Arrangement



Proposed Inter Planetary Network

3. Technologies for IPN

IPN Enabling Technologies:

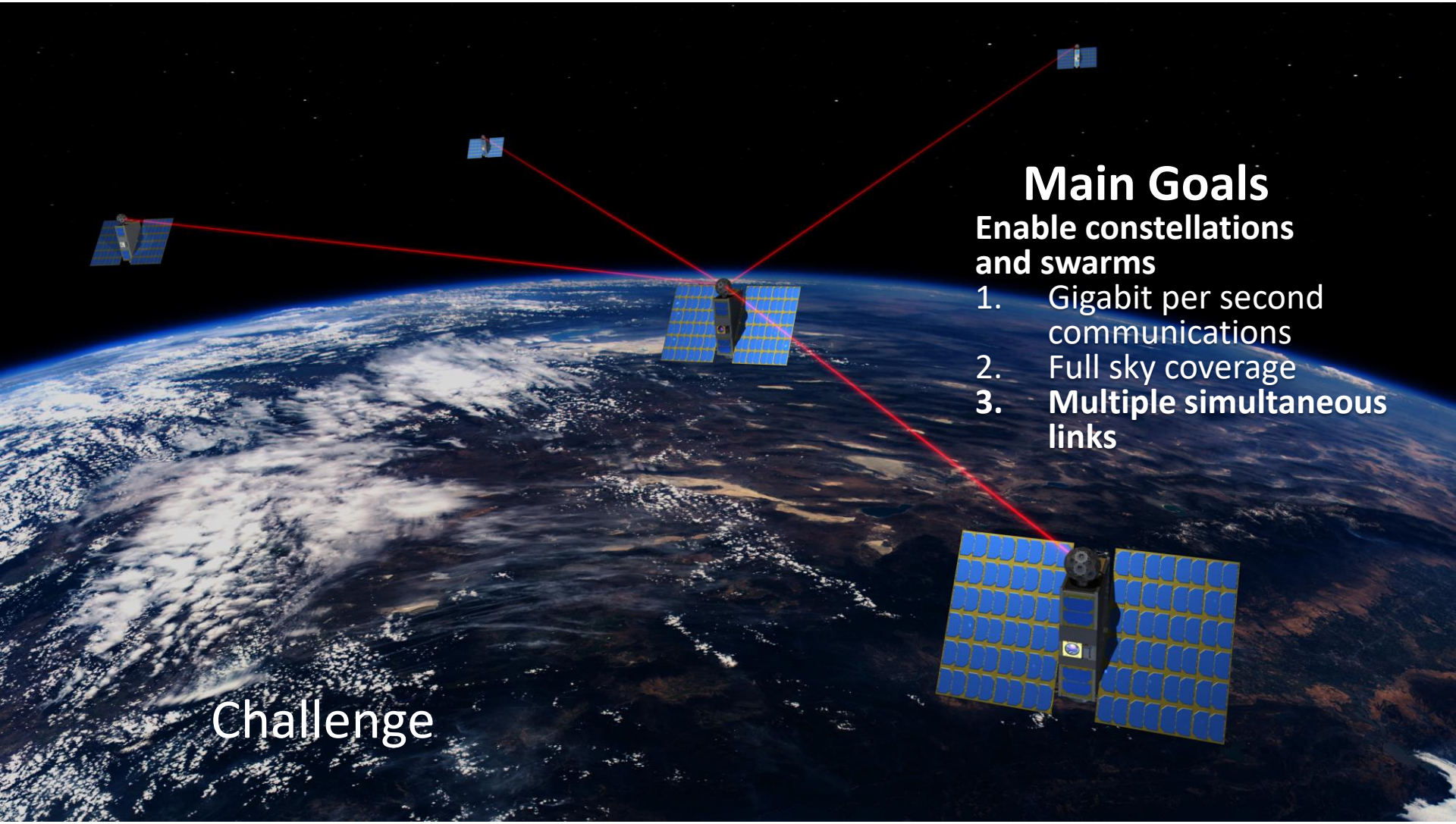
- Inter-spacecraft optical communications
- Miniature sensors
- Small and modular spacecraft
- Swarms
- Inter-swarm communications
- Solar system network (e.g. DTN)

3. Technologies for IPN

Inter-spacecraft optical communicator (ISOC)

IPN

3. Technologies for IPN



Main Goals

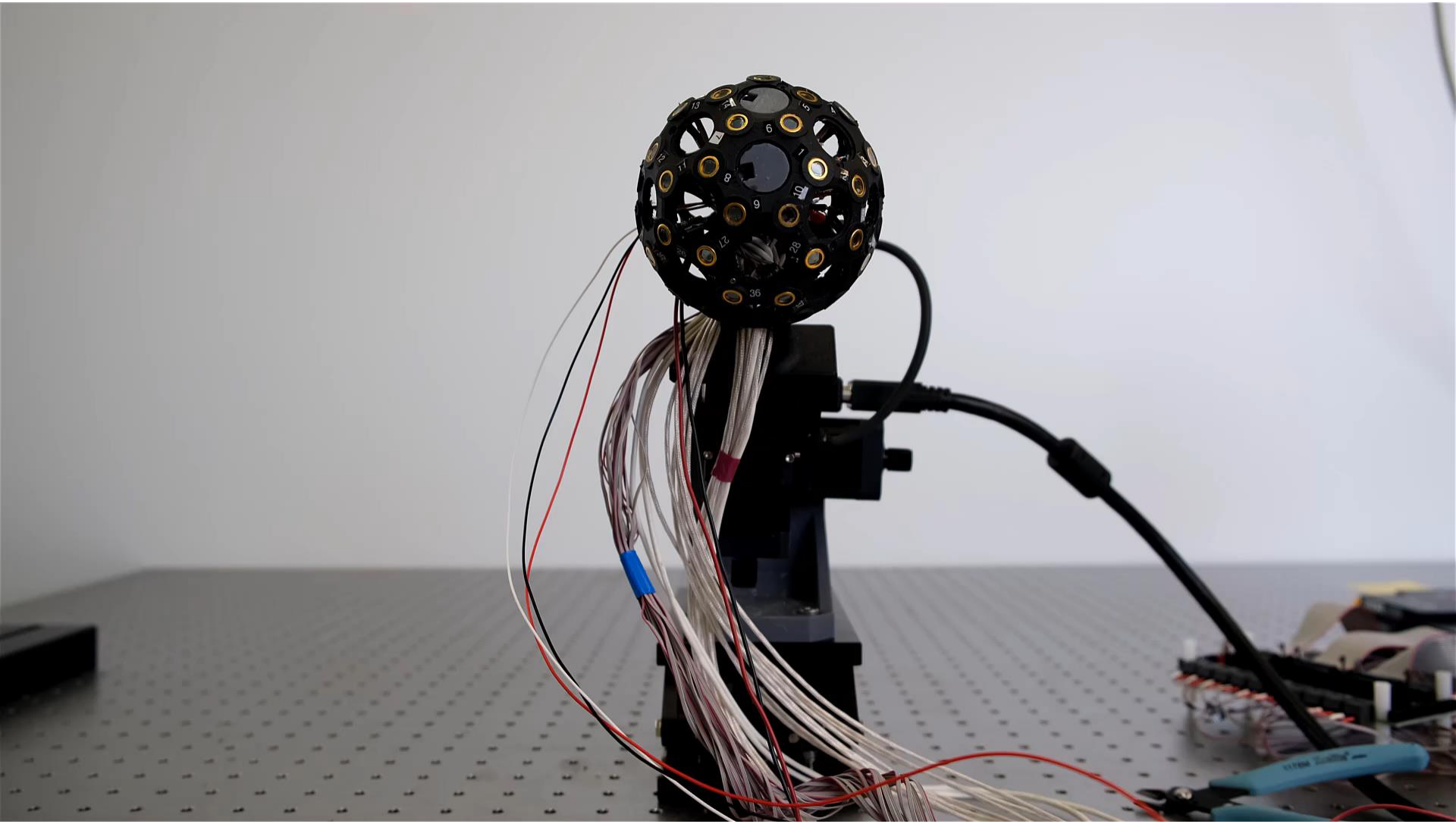
Enable constellations and swarms

1. Gigabit per second communications
2. Full sky coverage
3. **Multiple simultaneous links**

Challenge

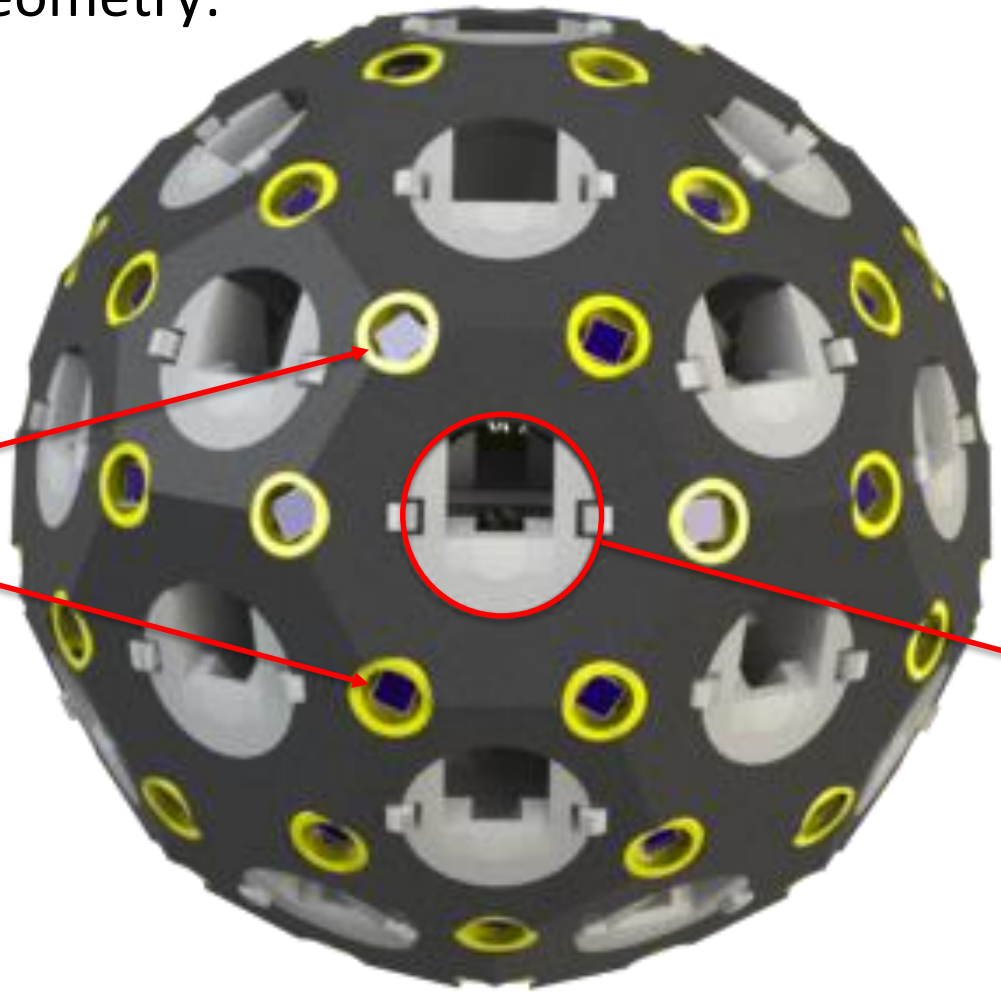
3. Technologies for IPN

Let me introduce to you the ISOC:



3. Technologies for IPN

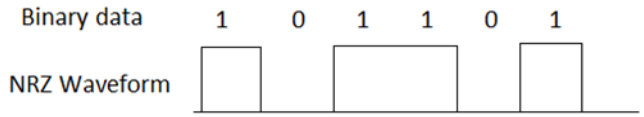
Basic ISOC geometry:

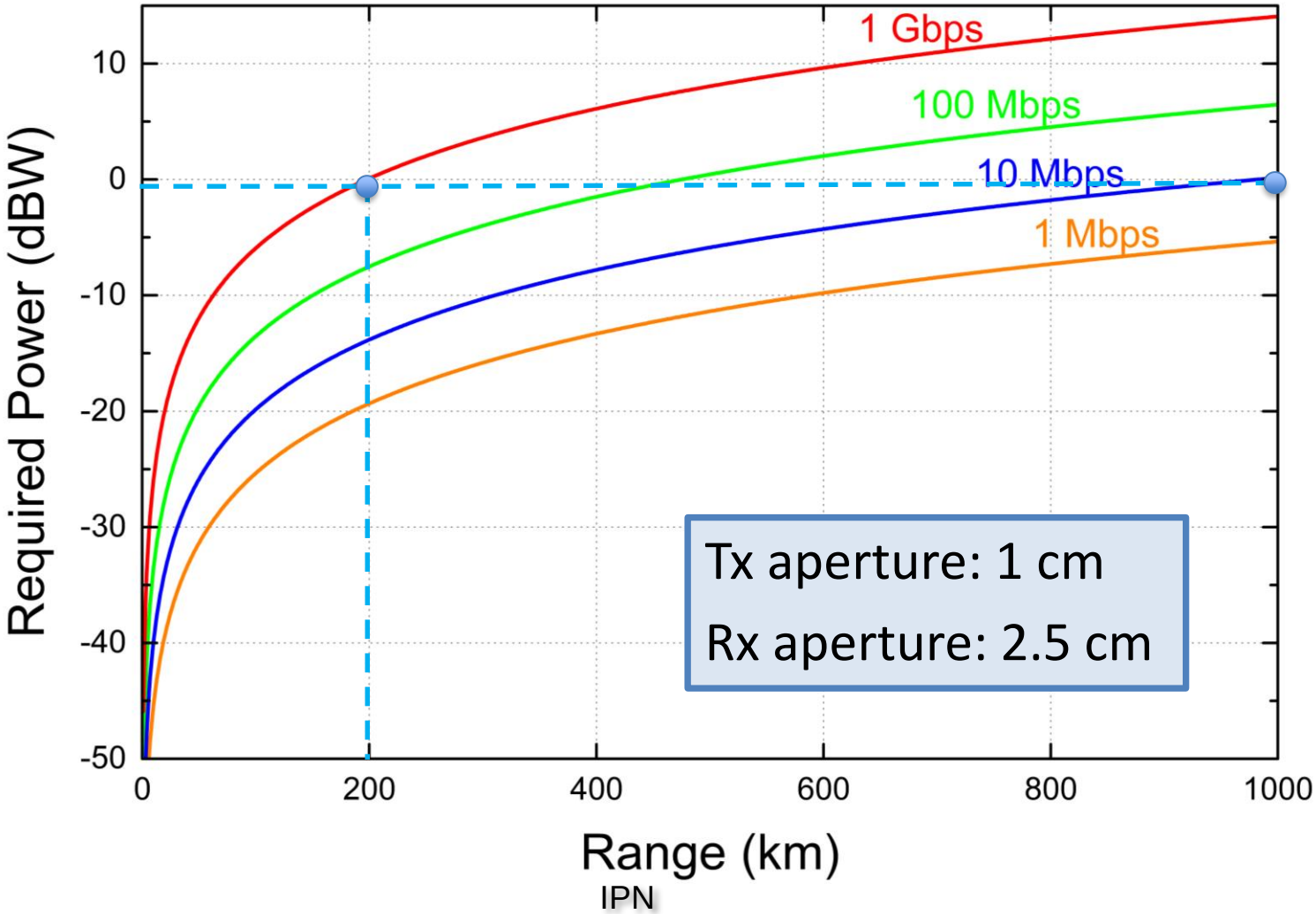


3. Technologies for IPN

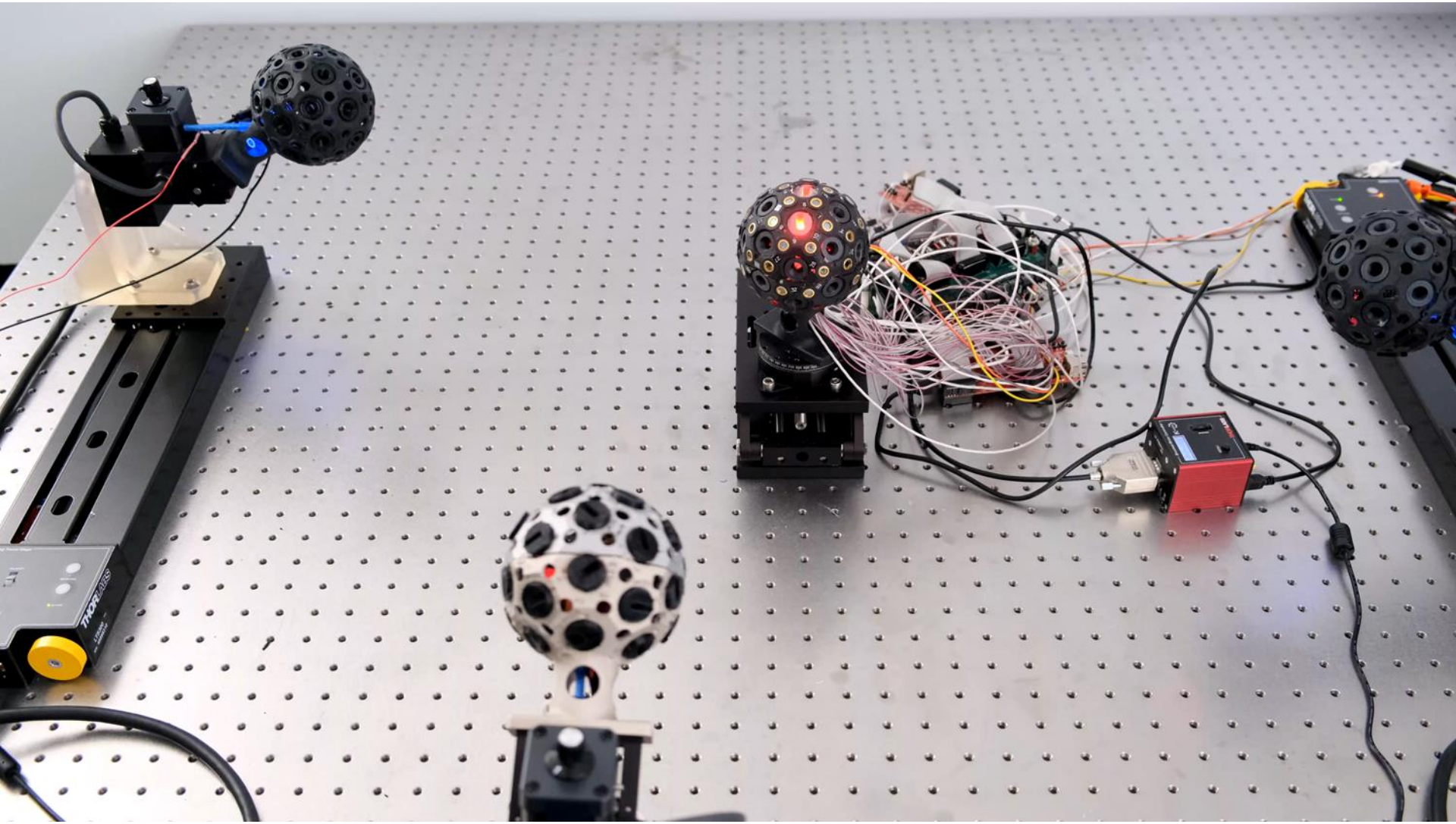
NRZ - OOK (On-Off Keying)

- Bandwidth (BW) = Bitrate (R_b)



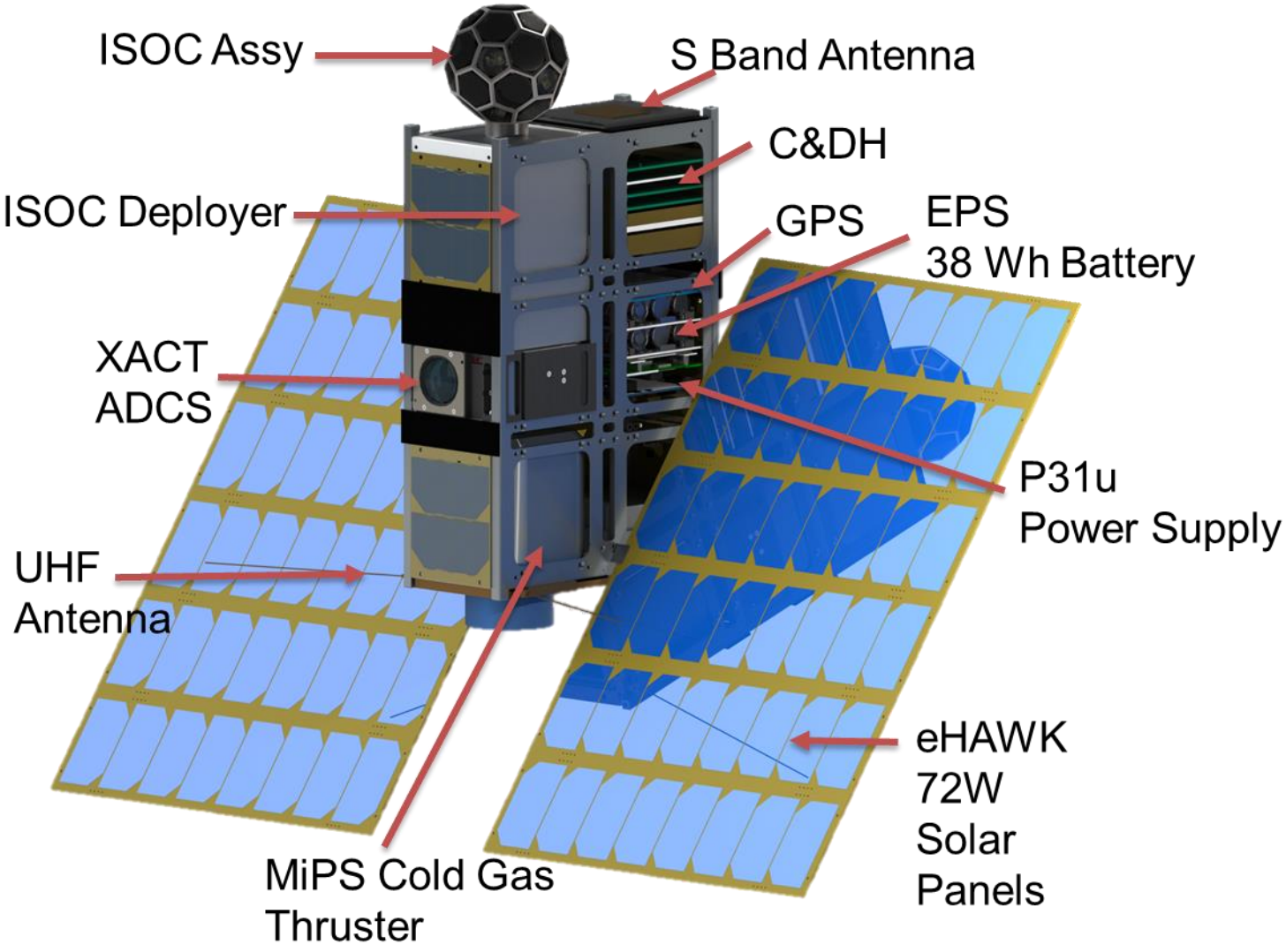


3. Technologies for IPN



Swarm emulator using automated platforms

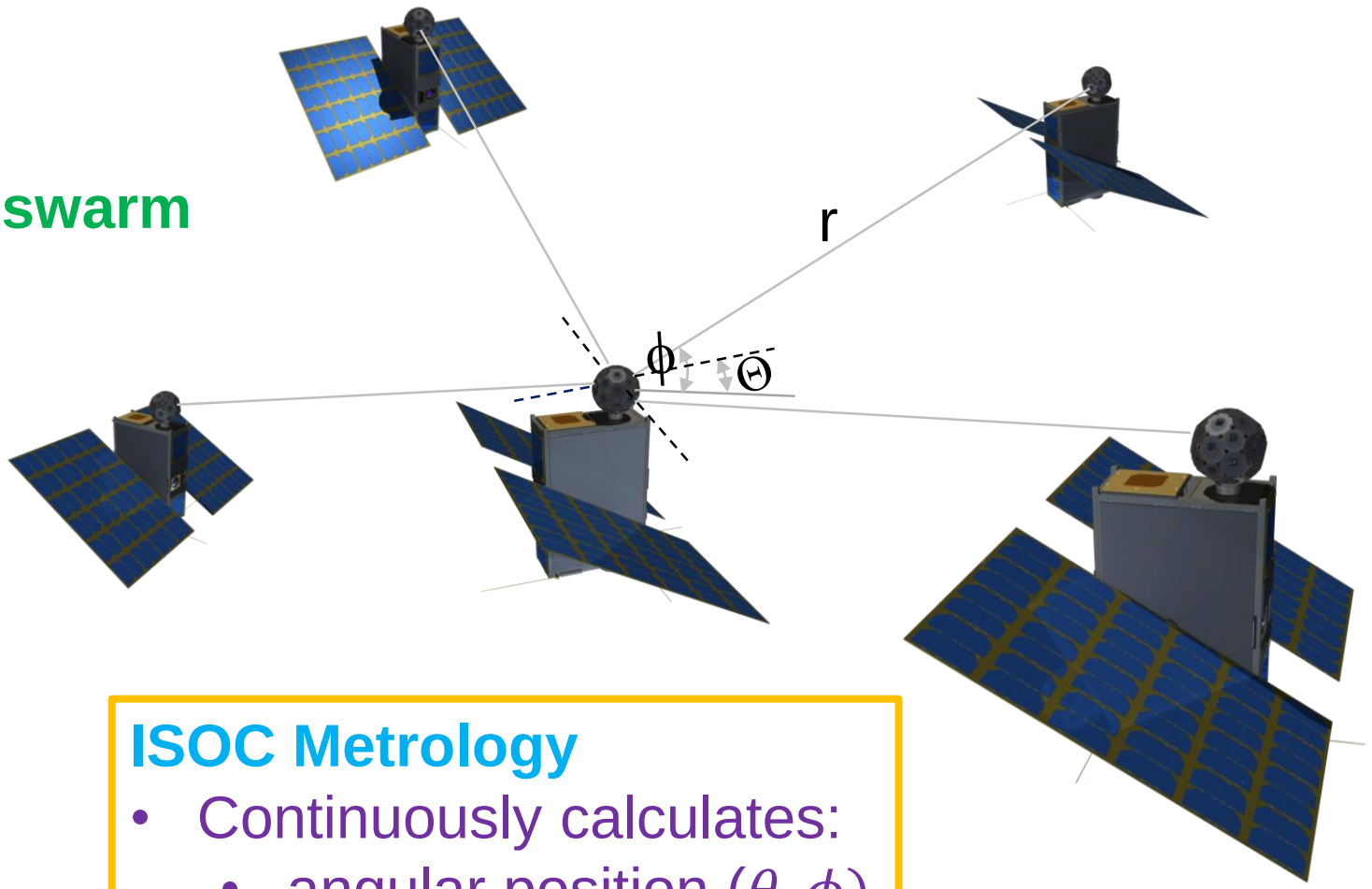
3. Technologies for IPN



CubeSat for IPN

3. Technologies for IPN

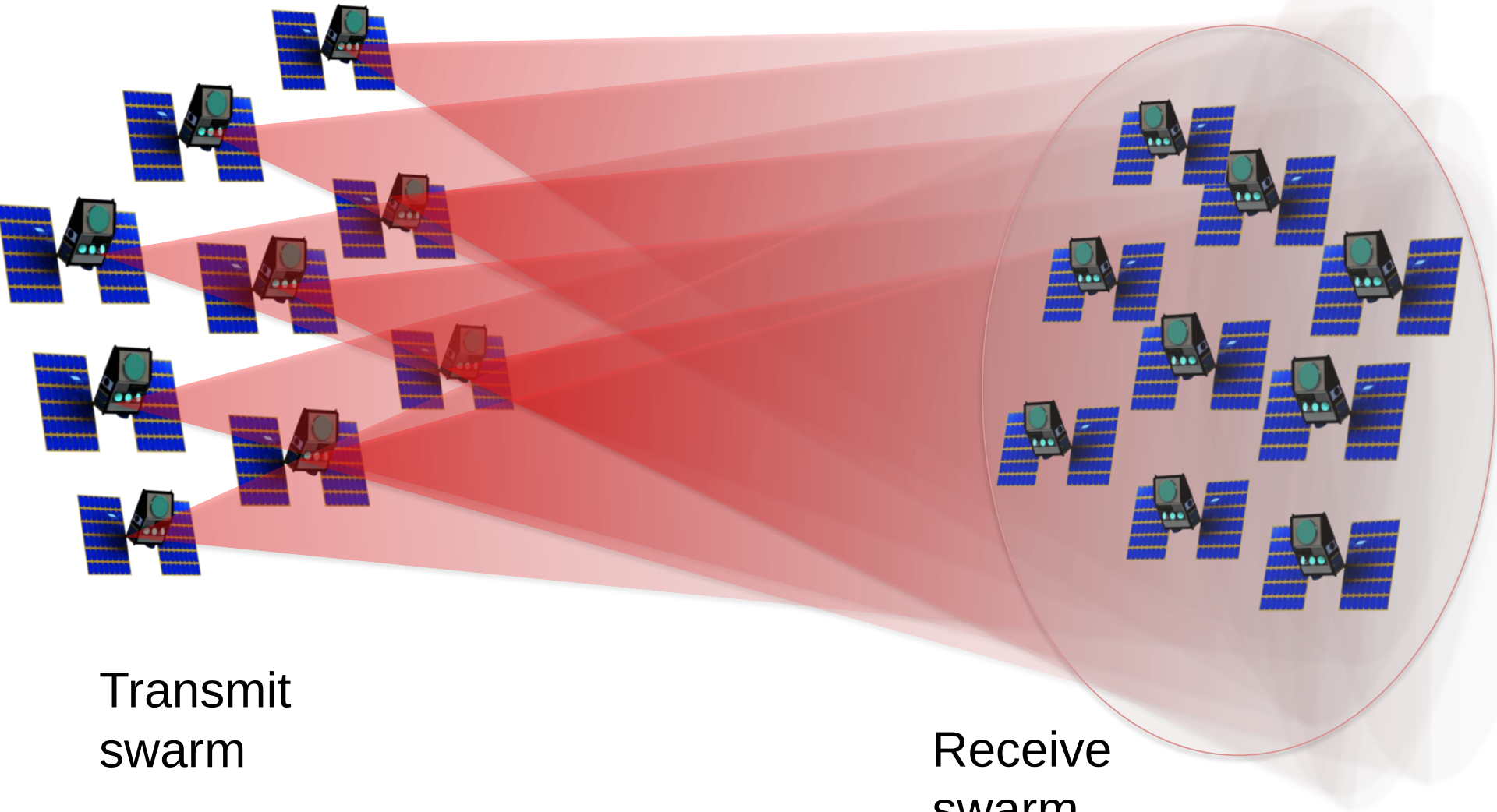
IPN swarm



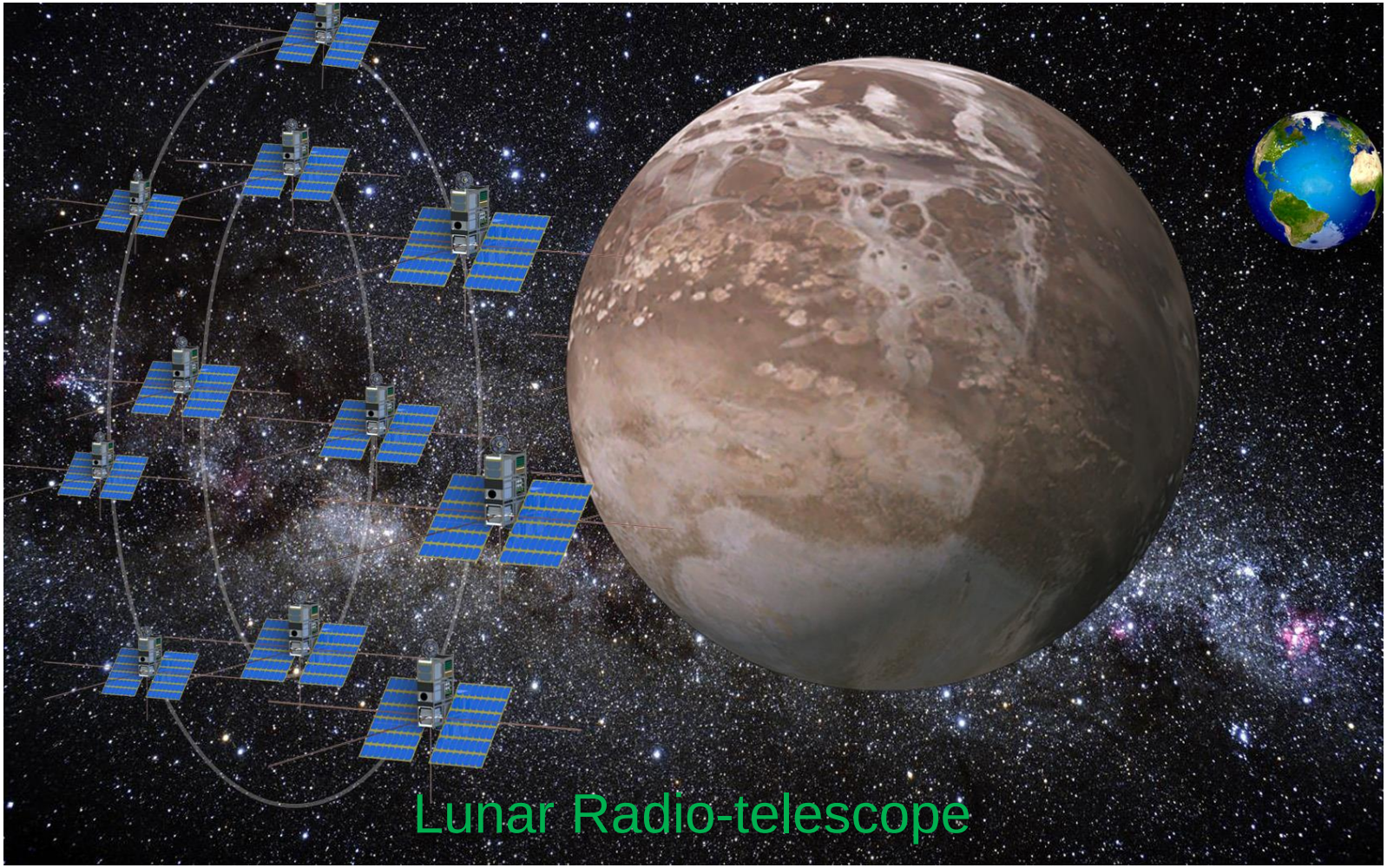
ISOC Metrology

- Continuously calculates:
  - angular position (θ, ϕ)
  - distance (r)

3. Technologies for IPN



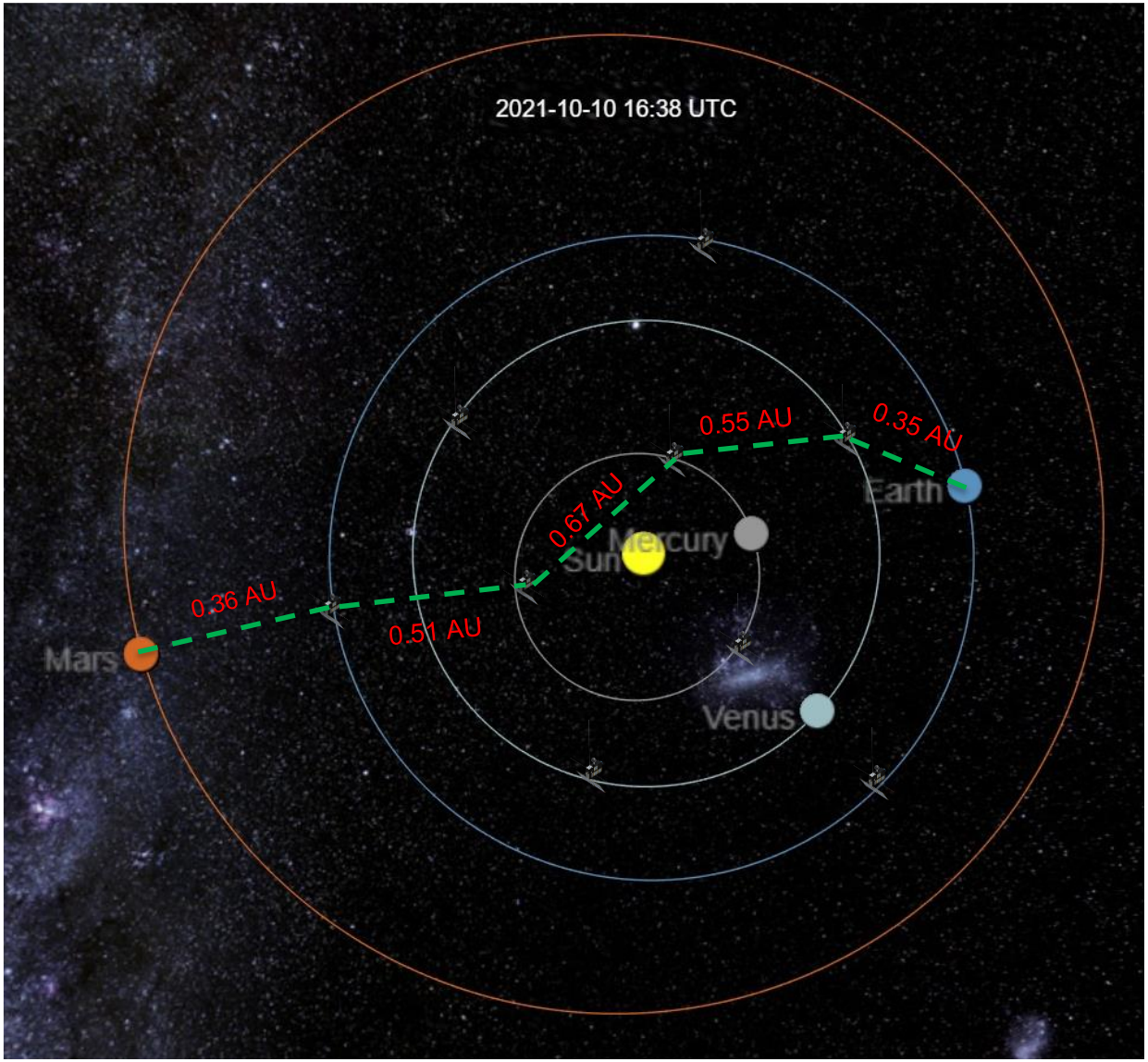
4. IPN Implementation



Example 1

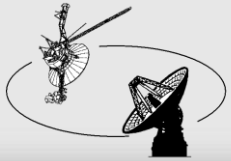
Cis-lunar IPN

4. IPN Implementation



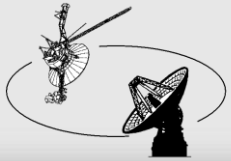
Example 2

IPN Inner-Solar System IPN



5. Conclusions

- The IPN is being proposed as a future solar system platform that could allow for outstanding science and fast communications.
- A building block for the IPN is the use of swarms of standardized small spacecraft.
- Each IPN spacecraft is furnished with suitable optical communications terminals and miniature sensor payloads.
- Future studies should include, potential science missions, deployment cadence of IPN spacecraft, cost, sensors, etc.



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