DEVELOPMENT OF AN RFID SYSTEM FOR SPS-ALPHA

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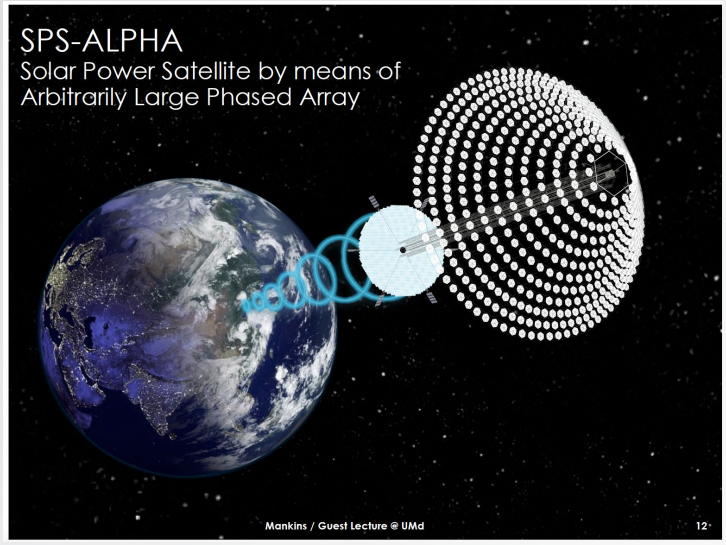
OBJECTIVES

RFID Implementation:

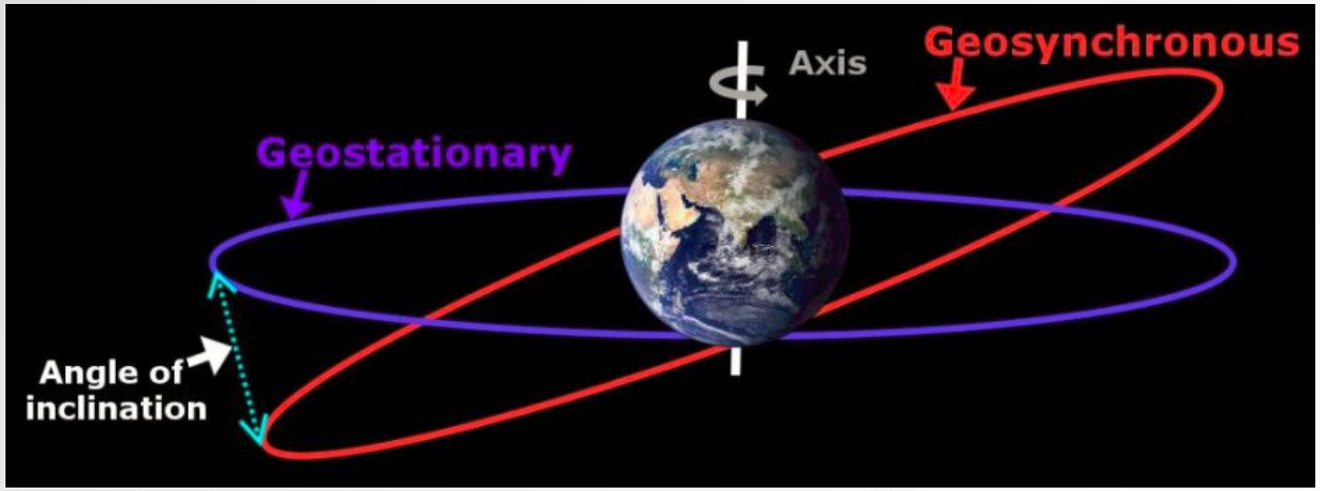
- SPS-ALPHA Structure
- RFID Technology
- Applications in SPS-ALPHA architecture
  - Part Identification
  - Location Referencing



Source: John Mankins, SSP Lecture @UMD-Jaffe 28FEB17 V1

Why Space Solar

- No atmospheric attenuation of sunlight
- No Day and Night cycle
- No weather losses



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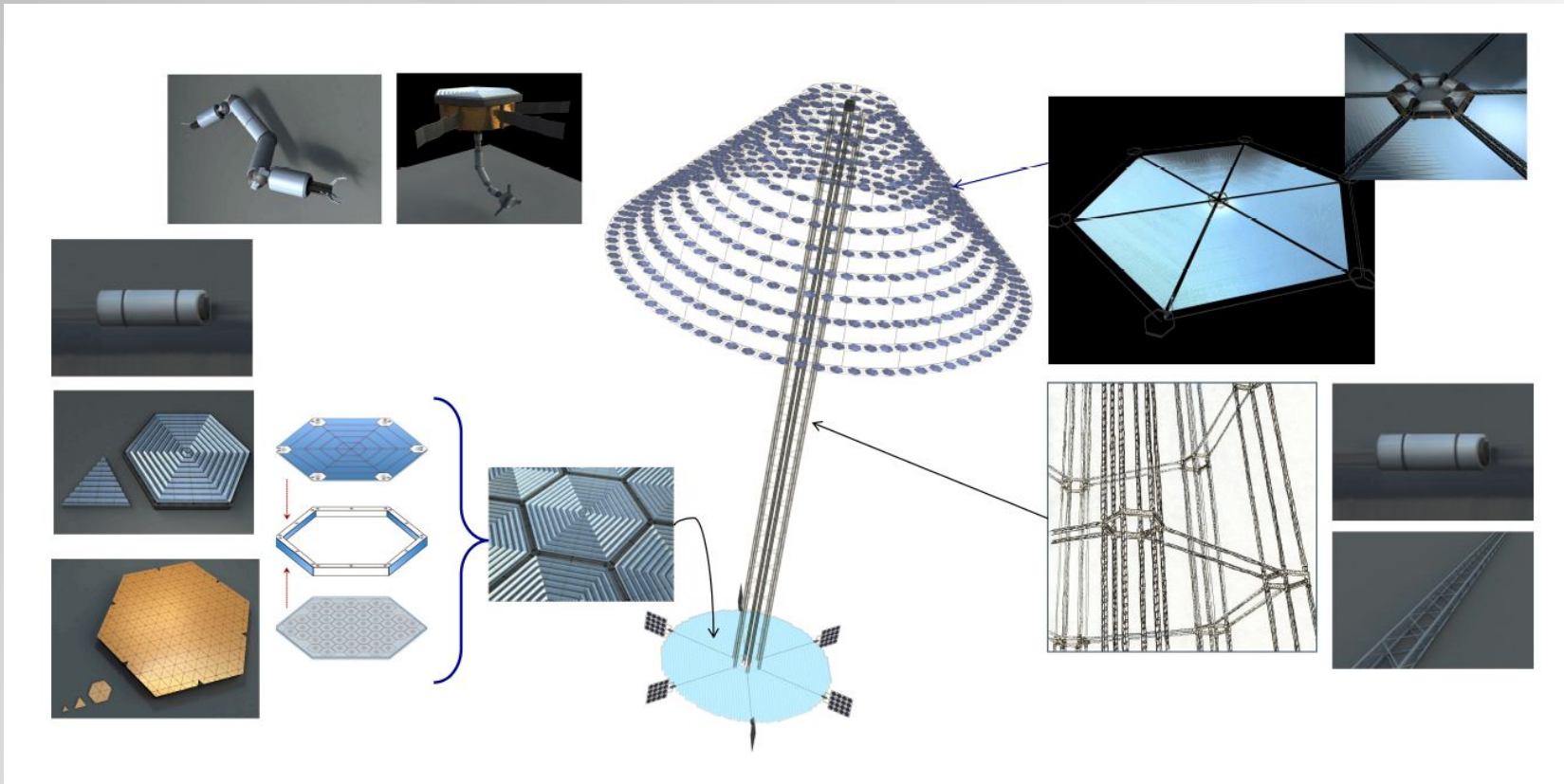
Source: EIA – www.scienceabc.com

SPS-ALPHA overview



Source: The Case for Space Solar Power by John C. Mankins

Modules and Assemblies

Table 5-2 Crosswalk from Modular Elements to Key Assemblies

Modular Elements	Key Assemblies*					
	Primary Array Assembly	Solar Reflector Assembly	Primary Structure Assembly	Connecting Truss Assembly	Propulsion & Attitude Control Assembly	Modular HexBot Assembly
HexBus	X	X	X	X	X	X
Interconnect	X	X	X**	X	X	
HexFrame		X	X	X		
RDM Module		X				
SPG Module	X				X	
WPT Module	X					
PAC Module					X	
MARE Arms		X**			X**	X

*** As noted, the Power/Transmitter Array comprises multiple copies of the Primary Array Assembly, and is not listed separately*

** This Module / Assembly combination may / will require tailoring of the Module involved*

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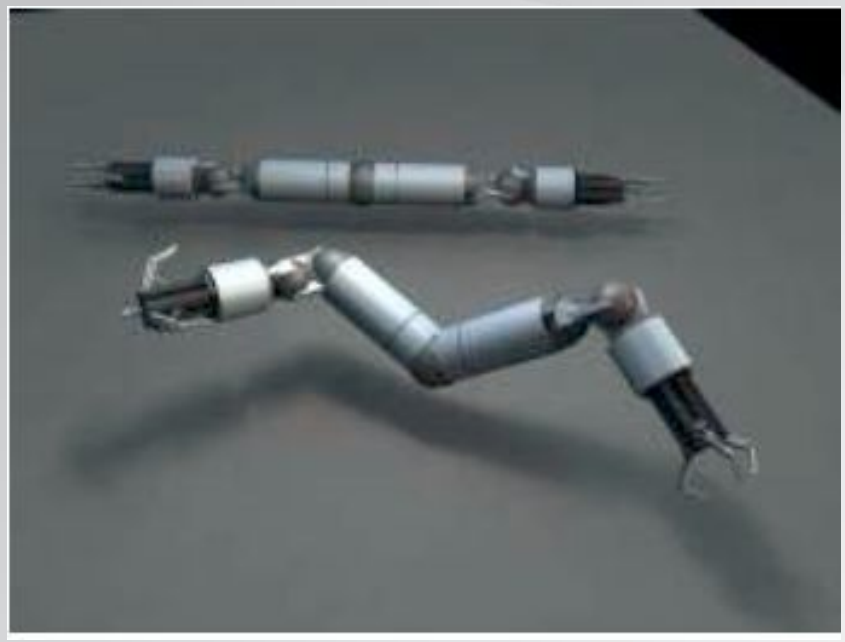
Source: The Case for Space Solar Power by John C. Mankins

Modular Autonomous Robotic Effectors (MARE)



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Source: The Case for Space Solar Power by John C. Mankins

Radio Frequency Identification (RFID) Technology

- Capable of sending data short distances
- Currently used in the ISS

NASA used Omni-ID on-metal tags for socks with metallic fibers.

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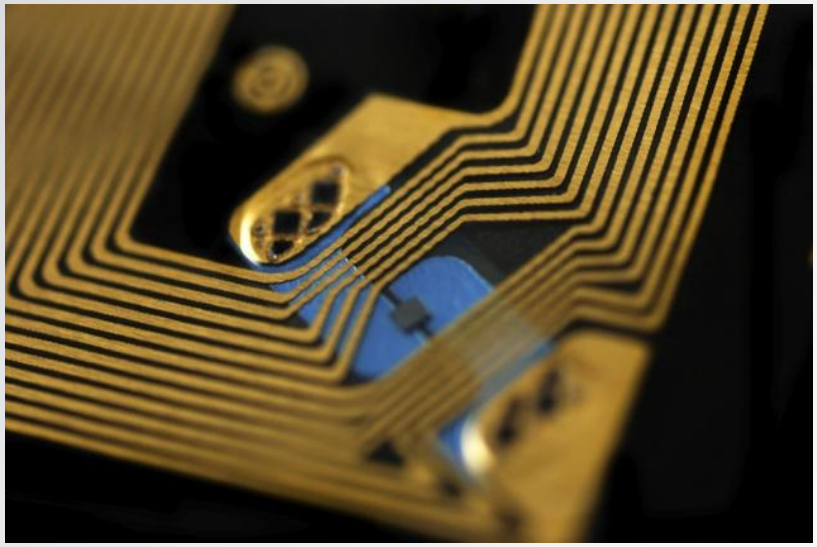
Source: NASA

Types of RFID

- Passive and active RFID tags
- Passive RFID tags do not require an internal battery; active RFID tags do
- Read only and Read-Write tags

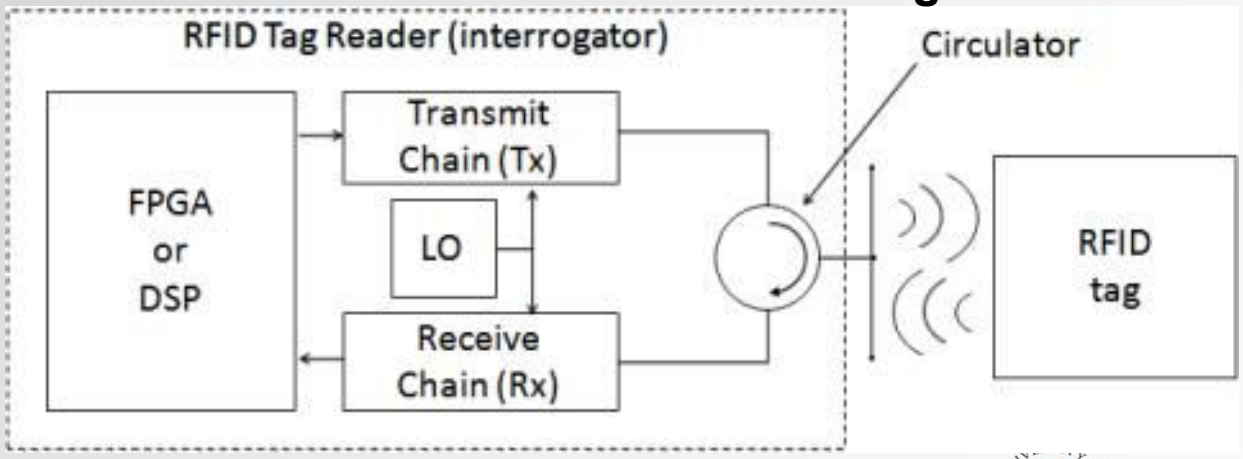


Source: http://news.mit.edu/sites/mit.edu.newsoffice/files/images/2016/MIT-RFID-Chip_0.jpg

How RFID is used

- RFID system consists of a reader and a tag
- Reader sends an electromagnetic signal to tag
- Tag sends data back by switching its input impedance between two states (high and low)

Passive RFID Circuit Diagram



Source: National Instruments

RFID Tag Selection

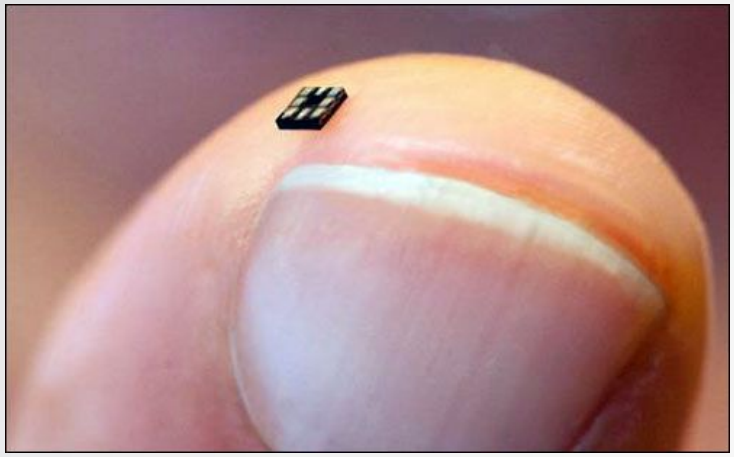
Passive RFID Tag Ranges

	Frequency	Transmission Range
Low Frequency	125 kHz	Less than 1 foot
High Frequency	13.56 MHz	Up to 3 feet
Ultra High Frequency	865 to 960 MHz	30+ feet
Microwave	2.4 to 2.5 GHz	100 + feet

Sources: National Instruments and Digikey

Why use RFID?

- Can be very small-capable of being embedded in SPS-ALPHA components
- Cost-effective
- Long-lasting
- Can be used in harsh environments
- Fast read & write time



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Sources: (Shirvani Moghaddam 541), (Smiley 5), and (Swedberg 1)

Example RFID Components

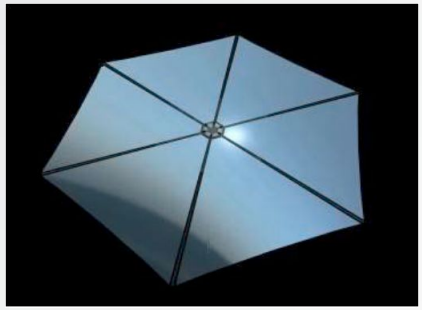
- AMS SL13A RFID Sensor Tag:
  - Operates at 13.56 MHz
  - Capable of operating from -40℃ ~ 110℃
  - 1 kB writable memory
- Texas Instruments TRF7960A Reader/Writer IC:
  - Operates at 13.56 MHz
  - Capable of operating from -40℃ ~ 110℃

Sources: Texas Instruments, Digikey and PEAWO

Part Identification System

- 8 different modules
  - Need at least 3 bits to represent them.
- 6 different assemblies
  - Need at least 3 bits to represent them.
- 4 byte Unique ID

00000101 =



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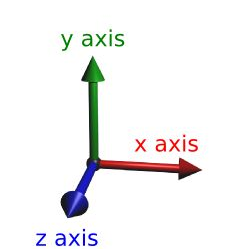
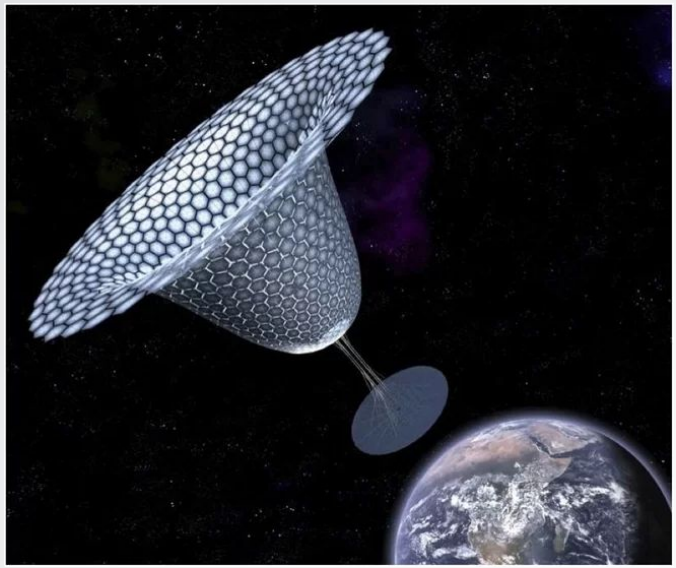
Source: The Case for Space Solar Power by John C. Mankins

Representing Location

Part Identification System Data Structure

Byte width:	128	874	4	4	4	4	1	1
	Parity	Operations Log	Z Pos	Y Pos	X Pos	Unique ID Field	Assembly Field	Module Field





Sources: (David 1), and ux.stackechange.com

Operations Log

Structure of Operations Log Entries

Byte Width:	**8**	**4**	**1**	**1**
	MARE ID	Time	Damage	Health

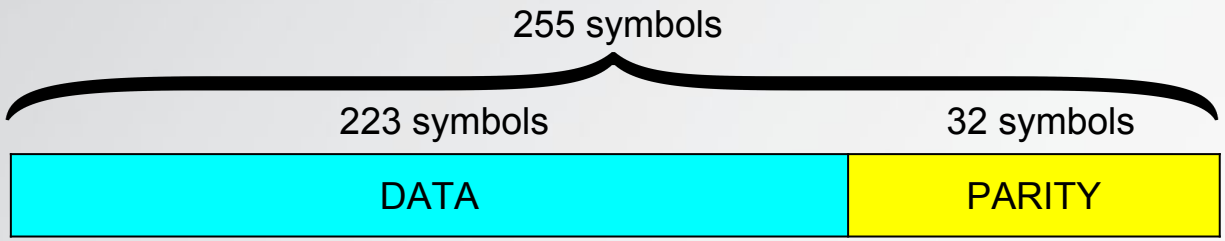
Structure of the Time Field

Bit Width:	**12**	**4**	**5**	**5**	**6**
	Year	Month	Date	Hour	Minute

Sources: (David 1), and ux.stackechange.com

Error Correction

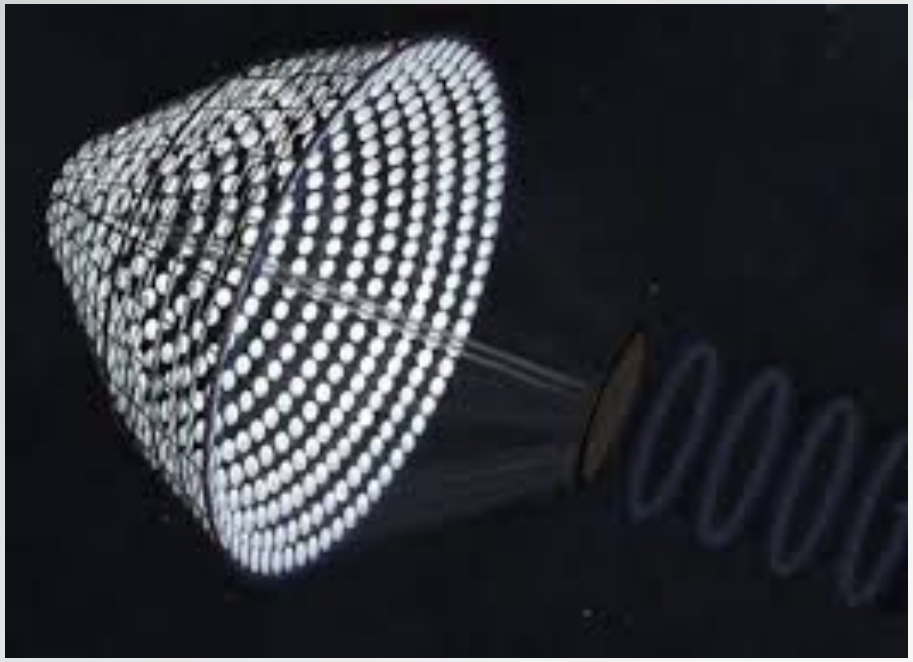
- Reed-Solomon error correction code
  - RS(255,223), k = 223 symbols , 2t = 32 symbols
  - 8-bit wide symbols



Source: (Riley and Richardson 1)

Future Work

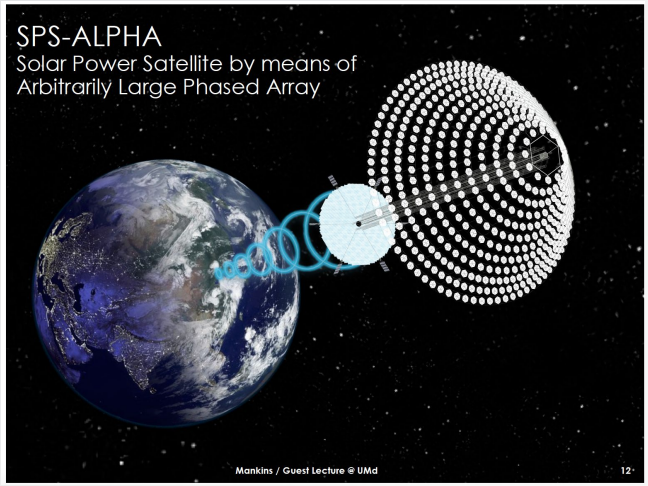
- RFID Tag Interference



Source: National Space Society

Conclusion

- SPS-ALPHA Structure
- RFID Technology
- Applications in SPS-ALPHA architecture
  - Part Identification
  - Orderly in-space assembly of SPS-ALPHA
  - Easier navigation and maintenance of satellite once constructed



Source: John Mankins, SSP Lecture @UMD-Jaffe 28FEB17 V1

Questions?

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