

***Space Telescopes***  
***Asteroid Mining***  
***Space Manufacturing***

***SPACEFAB.US***





# Business Road Map

## Cost efficient high value space telescopes

- Unique business model
- “Deployable optics” technology

## Asteroid mining

- Priority on metal asteroids

## Exponential Space Manufacturing

- Fully automated In-Space manufacturing





# *Space Telescopes*

***SPACEFAB.US***





# Space Telescope Business

- **The** first commercial space telescope, for **both** Earth observation and space astronomy
- Maximize revenue
  - Earth observation on daytime side
  - Astronomy on night time side



# Why Astronomy From Space

- Always perfect observing conditions
- Free of weather problems, atmospheric distortion, light pollution from city lights
- 24 hour operation, not just at night
- Longer camera exposure times
- Both Northern and Southern hemispheres are viewable
- All IR and UV wavelengths viewable, unblocked by atmosphere



# Space Observatory Services Market

- \$100M annual Total Available Market for professional and amateur astronomers
- Only a few professional and amateur astronomers have access to a space based telescope → severe shortage of availability
- Market can be *profitably* serviced from our initial satellite
- Working with a major US university on multi-million dollar NSF funded program, US colleges get access to our space telescope



# Earth Observation Services Market

- **\$1.6B annual Total Available Market**
  - **Commercial mapping**
  - **Agriculture analysis**
  - **Pollution monitoring**
  - **Weather prediction**
  - **Security and Defense**





# Waypoint Space Telescope Satellite

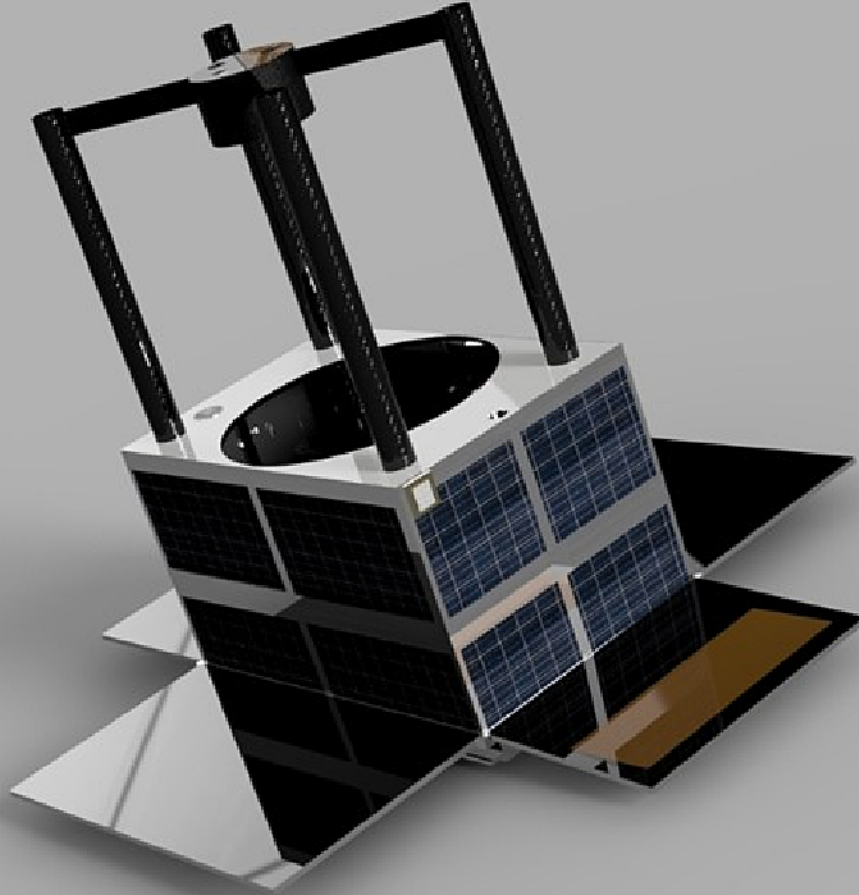
- Design, build, and launch satellite #1 in 2019
  - A corporate partner will subsidize the launch cost
  - 18 kg, 12U cubesat
  - Corrected Dall Kirkham telescope, 21 cm diameter
  - Deployable secondary mirror cuts spacecraft structure cost and launch cost in half
  - Image processing accelerated by on-board hardware
  - Three powerful cameras

# Waypoint Space Telescope Satellite

- High resolution 48 Mpixel visible and near-IR camera
  - Astronomy: .6 arcsecond resolution
  - Earth observation: 1 meter GSD, super-resolution mode
- Image intensified ultraviolet 8 Mpixel EMCCD camera
  - Exposure time reduced by 20X
- 150 band hyperspectral camera
  - 470 nm to 900 nm
  - 3 meter GSD



# SpaceFab Waypoint Space Telescope



# SpaceFab Waypoint Space Telescope

- Cameras for UV, visible, and hyperspectral imaging
- Laser communications to our optical ground stations
- SpaceFab deployable mirror technology provides Waypoint with 3X to 35X reduction in cost



<i>Satellite</i>	<i>Mass</i>	<i>Cost, incl. launch</i>	<i>Mirror Size</i>	<i>Ground Resolution</i>
<b>SpaceFab Gen1</b>	<b>18 kg</b>	<b>Lowest</b>	<b>21 cm</b>	<b>1 m</b>
Black Sky / SCOUT	55 kg	\$7M	25 cm	1 m
Beijing-1	166 kg	\$60M	31 cm	4 m
Razaksat	180 kg	\$70M	30 cm	2.5 m



# Waypoint Satellite Marketing Plan

- **Astronomical imagery**
  - Low resolution is free
  - Public and private repositories
  - Archived and tasked imagery on demand
  - Subscription – access to all high resolution public data
- **Earth observation imagery**
  - Free low resolution
  - Archived and tasked imagery on demand
  - High resolution 1 meter GSD



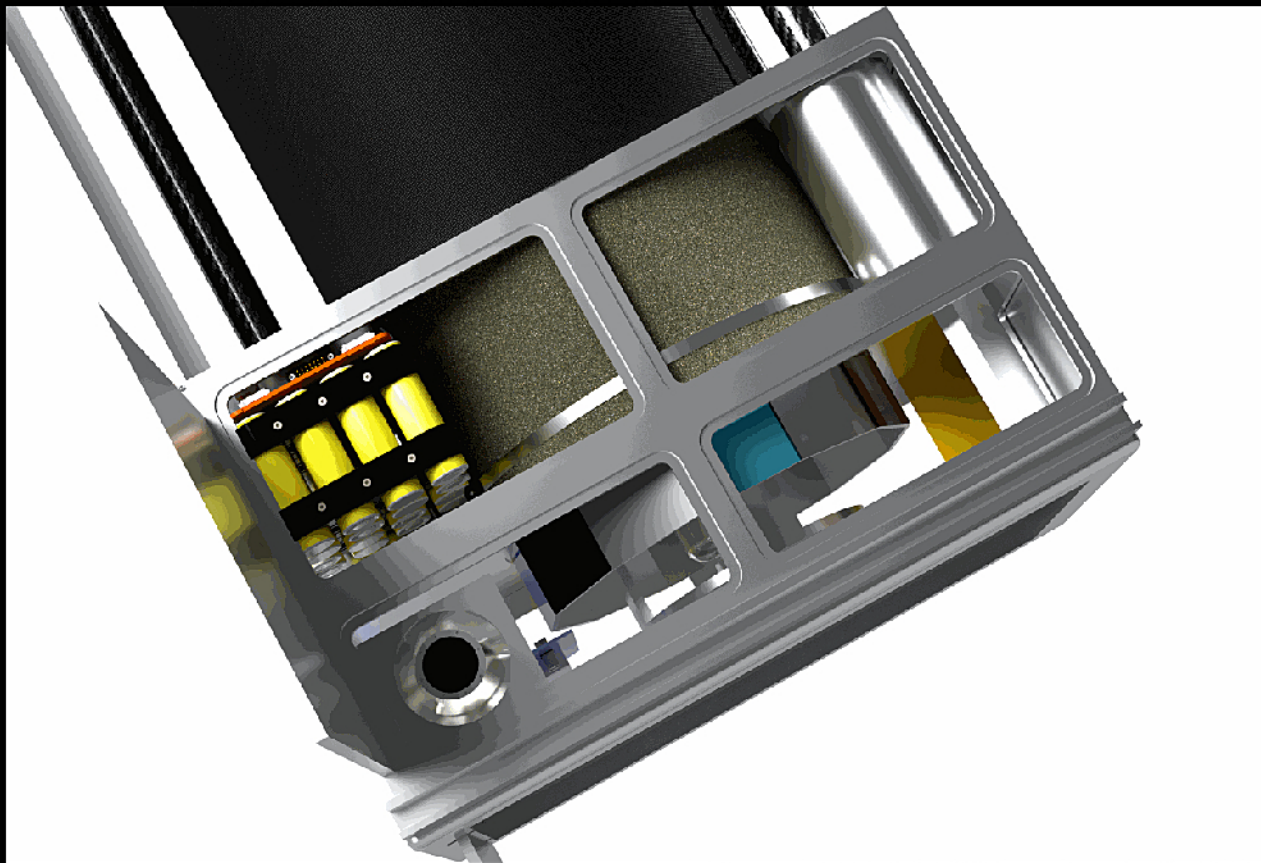
# Waypoint Satellite Future Development



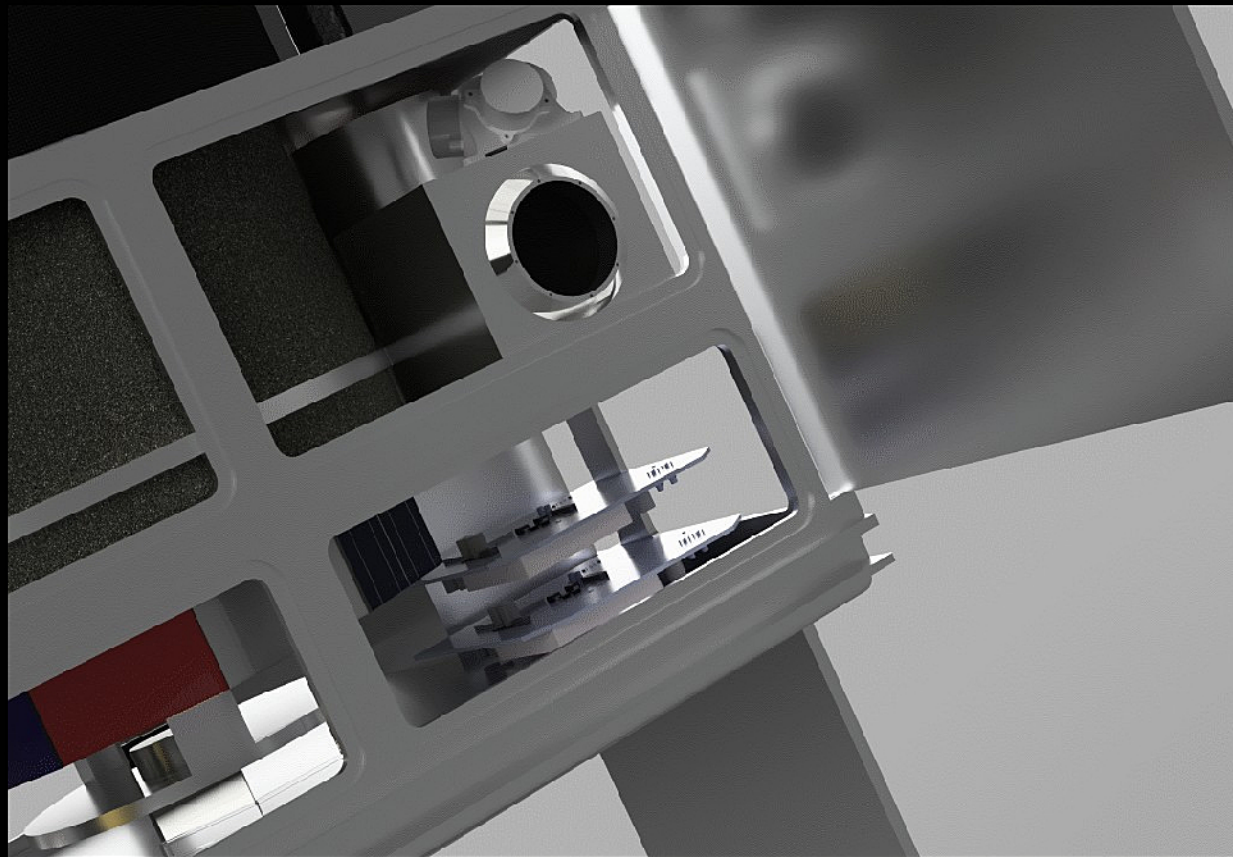
- **Build and launch constellation**
  - Four Waypoint satellites fit on a \$3M launcher
  - Low cost constellation with 1 meter GSD and high revisit rate
- **Future very high resolution optical satellite**
  - 30 cm GSD, super-resolution mode
  - Deployable secondary mirror cuts weight, size, and cost by an order of magnitude
  - Each satellite can be launched by a \$10M launcher



# Waypoint - Interior View



# Waypoint - Interior View





Customers can take pictures like this from our satellite



Customers can take pictures like this from our satellite



**M83**

.6 arcsec / pixel



Customers can take pictures like this from our satellite



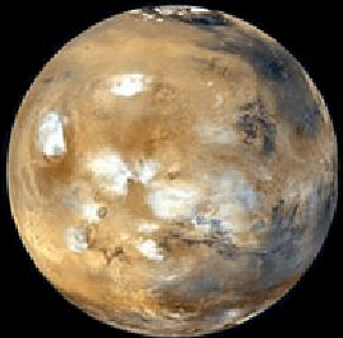
**M51**

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**ASTEROID MINING**

**SPACE MANUFACTURING**



# Space Manufacturing Business Line

- **Asteroid Mining and Exponential Space Manufacturing**
  - Build on technology from Space Telescope business
  - Robotic processing of metal asteroids into bulk metals
  - Make and assemble metal tooling and machinery using 3D printing and CNC machine tools
  - Exponential growth in manufacturing capacity
  - Provide in-space manufacturing as a service



# Exponential Reduction In Costs

- Fully automated in-space manufacturing will drive most costs down to zero
  - Raw material and real estate cost: zero
  - Continuous reduction in costs of labor, energy, equipment, and transportation means fabrication costs will approach zero
- Large billion dollar structures such as power beaming satellites or large space stations will become affordable

# Intellectual Property

- **Patent pending ion accelerator**

- **Additional intellectual property to be filed**

- telescope vibration control system
- extendable boom
- repairable robotic arm

# Who We Are

## Randy Chung, Co-founder, CEO and Chairman of the Board

- Founder of EdgeStream, Inc. , Internet streaming video delivery
  - CTO for 15 years, system and software
- System and integrated circuit Electrical Engineer, total of 25 years
  - Satellite engineering, radar signal processing at Hughes Aircraft
  - Developed a billion dollar product, world's first single chip hard disk controller at Western Digital, used in IBM PC-AT
  - Developed CMOS imager integrated circuit products at Rockwell Semiconductor and Conexant

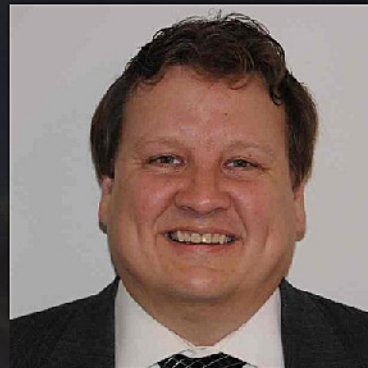




# Who We Are

## Sean League, Co-founder & Spacecraft Engineering Director

- Experienced company founder of US Telescopes, Inc.
- Astrophysicist, optical networking engineer, observatory and telescope sales and design
- nLight Inc. (anti-missile lasers), MCI Worldcom, Nortel



# Partners

## **Dr. Robert Chung**, Member of SpaceFab.US Board of Directors

- Visiting Professor at University of California at Berkeley, experienced in demography and statistical analysis

## **Yen Choi**, Member of SpaceFab Board of Advisors



- Co-founder and Board Member of Fibersat, a satellite operator. Co-founder and Board Member of Netcom Africa, a pan African Network Services Provider.

## **Richard Hedrick**, Member of SpaceFab Board of Advisors



- President and CEO of PlaneWave Instruments, manufacturer of observatory class astronomical telescopes.