



*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

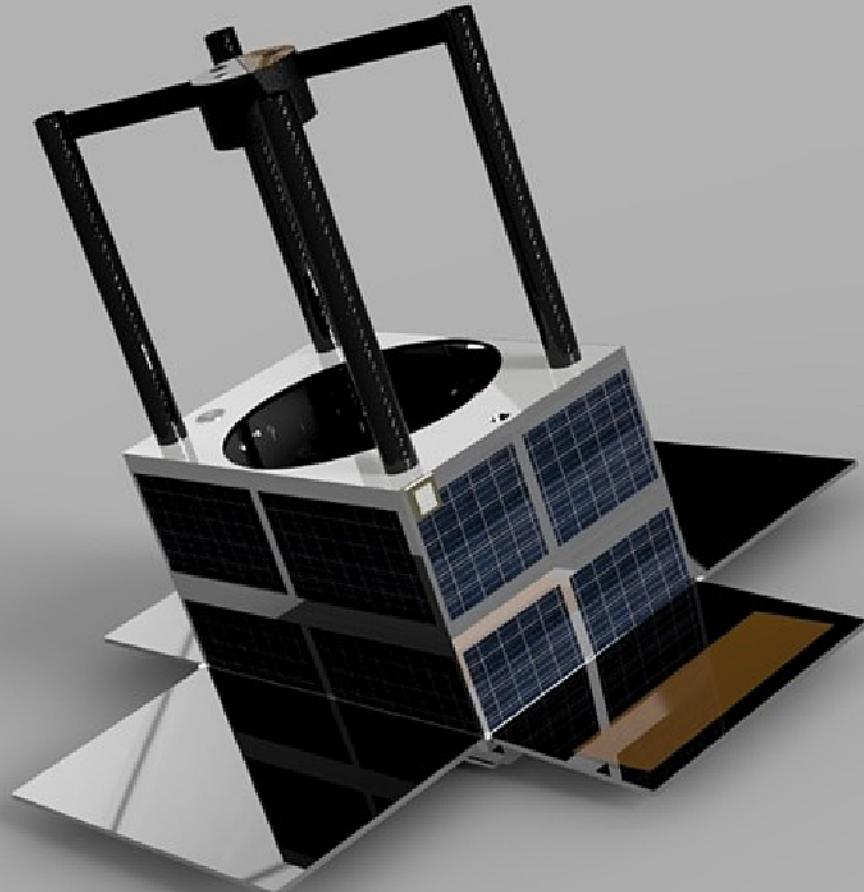
- Design, build, and launch satellite #1 in 2019
 - A corporate partner will subsidize the launch cost
 - 18 kg, 12U cubesat
 - Corrected Dall Kirkham telescope, 21 cm diameter
 - Deployable secondary mirror cuts spacecraft structure cost and launch cost in half
 - Image processing accelerated by on-board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



Waypoint Space Telescope Satellite

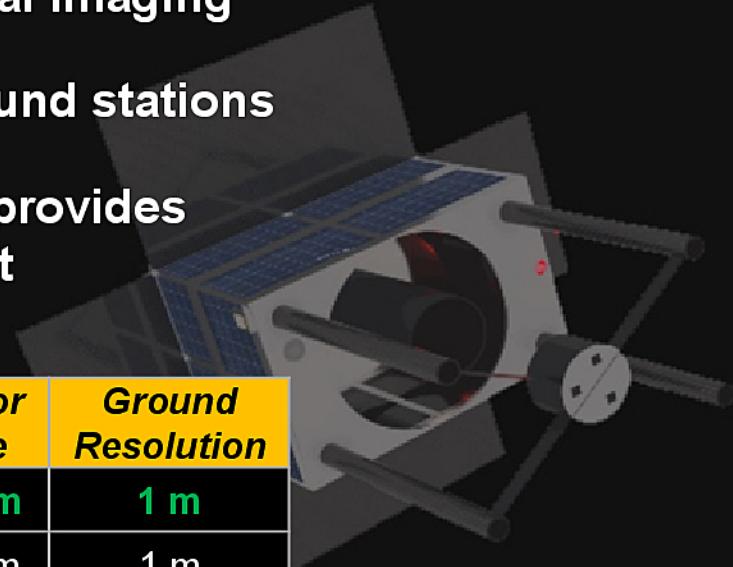
- High resolution 48 Mpixel visible and near-IR camera
 - Astronomy: .6 arcsecond resolution
 - Earth observation: 1 meter GSD, super-resolution mode
- Image intensified ultraviolet 8 Mpixel EMCCD camera
 - Exposure time reduced by 20X
- 150 band hyperspectral camera
 - 470 nm to 900 nm
 - 3 meter GSD

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



Satellite	Mass	Cost, incl. launch	Mirror Size	Ground Resolution
SpaceFab Gen1	18 kg	Lowest	21 cm	1 m
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

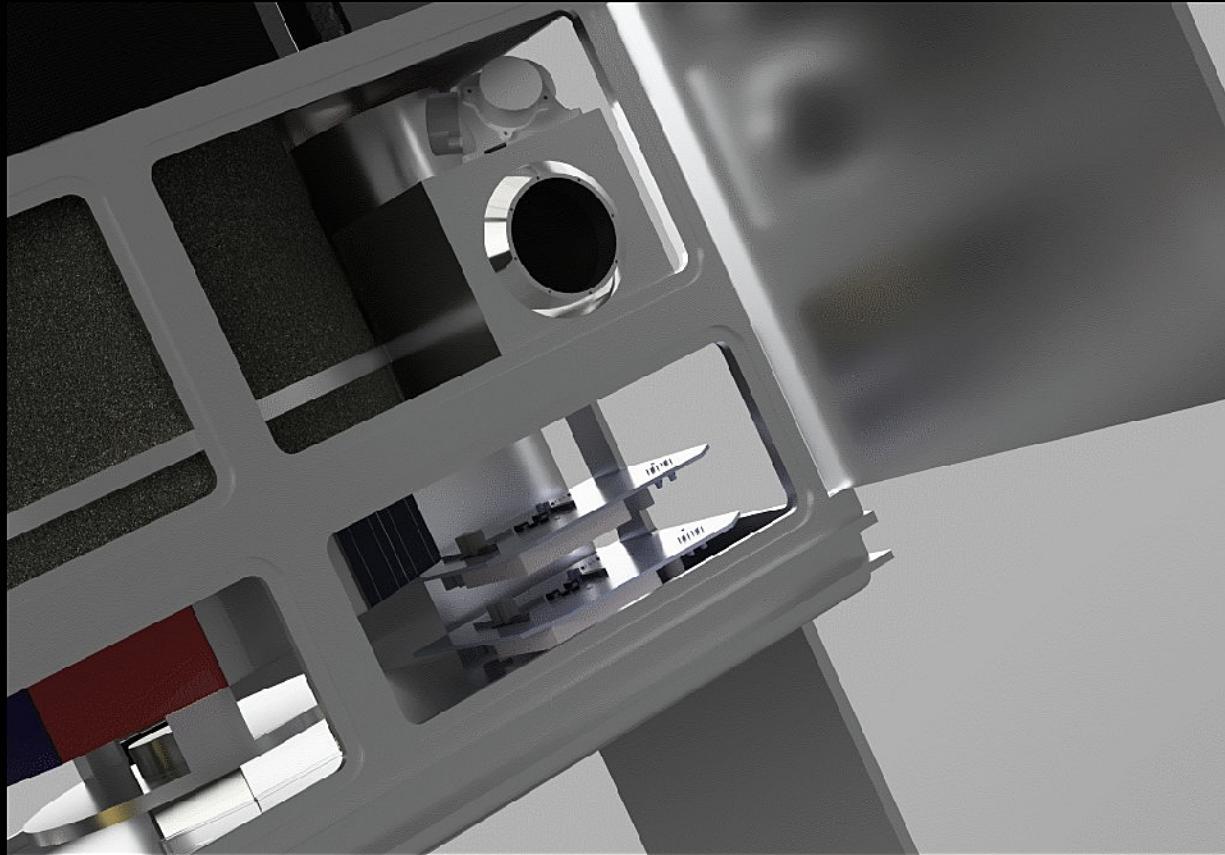
- **Build and launch constellation**
 - Four Waypoint satellites fit on a \$3M launcher
 - Low cost constellation with 1 meter GSD and high revisit rate
- **Future very high resolution optical satellite**
 - 30 cm GSD, super-resolution mode
 - Deployable secondary mirror cuts weight, size, and cost by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



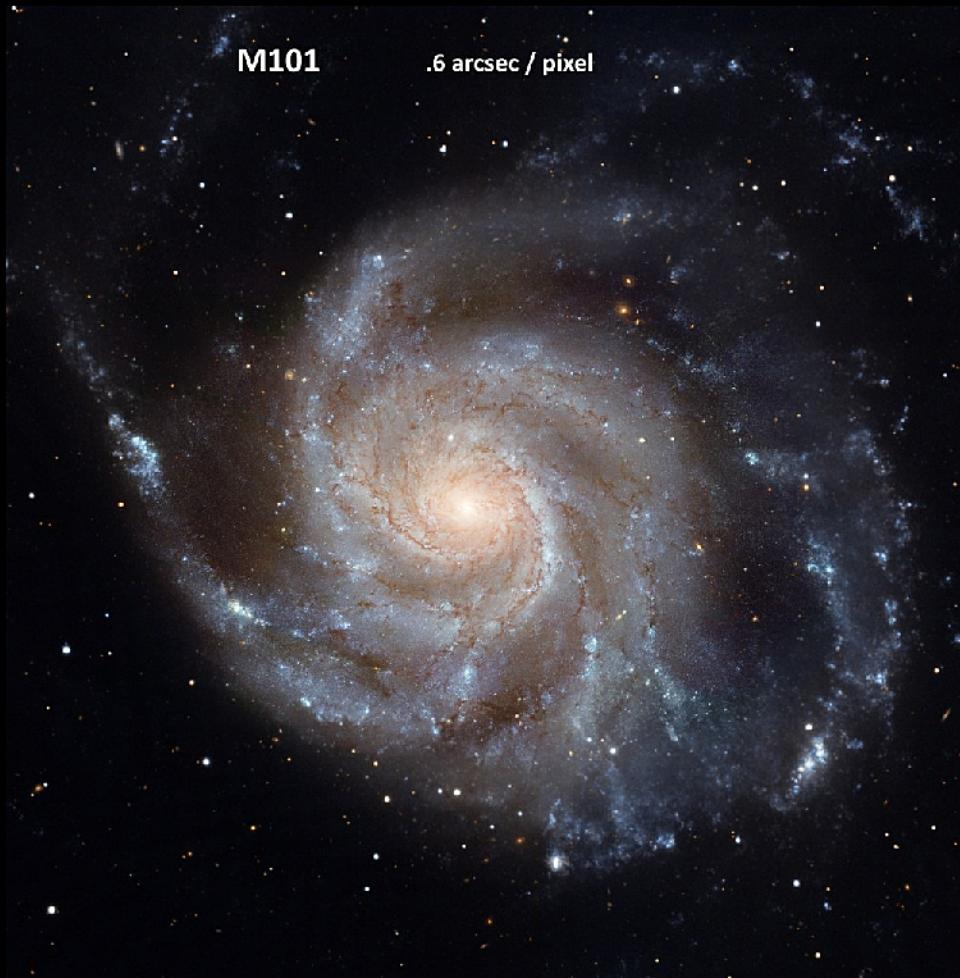
Waypoint - Interior View



Waypoint - Interior View



Customers can take pictures like this from our satellite



Customers can take pictures like this from our satellite



Customers can take pictures like this from our satellite



M51
.6 arcsec / pixel

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.