In-Space Additive Manufacturing of Spacecraft Structure

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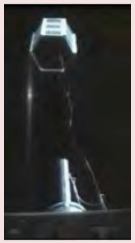
Background: Tethers Unlimited, Inc.

Tethers Unlimited
Transformative Technologies for Space, Sea, Earth, & Air

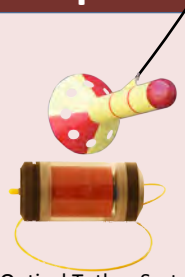
- **TUI Develops Advanced Technologies for Space & Defense**
- **21 years in operation; 30 employees; $4M FY15; Profitable**
- **Clients: NASA, Air Force, Army, Navy, Space Primes, & NewSpace**
- **Commercialized multiple SBIR technologies & supported multiple flight missions**

Core Technology Areas

Tether Systems for Space and Defense



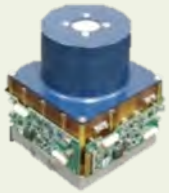
Propulsion & De-orbit Solutions



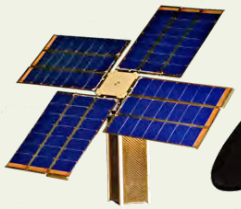
Optical Tether Systems

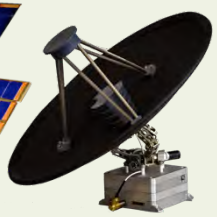
Launchable Anchor

High-Performance SmallSat Components

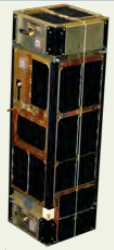


HYDROS Thruster



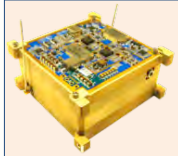


Antennas, Arrays, & Gimbals



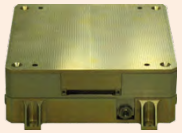
CubeSat Systems

Software Defined Radios



UHF

S-&L- // AFSCN



Wideband

SWIFT SDR

X-Band

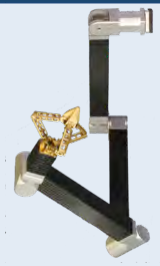
K-Band

In-Space Manufacturing

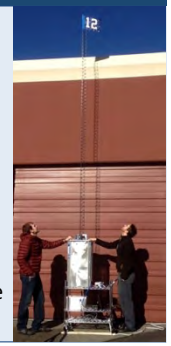
Multifunctional Shielding & Insulation

In-Space Recycling

High-Dielectric 3DP



In-Space Manufacture & Assembly



This is how we currently deploy large space systems


This is how we should.

Vision

Create a '**Satellite Chrysalis**', consisting of:

- **Raw material** in a compact, durable state
- **Software DNA** assembly instructions
- Capability to **fabricate** and integrate components **on-orbit** to form an operational space system

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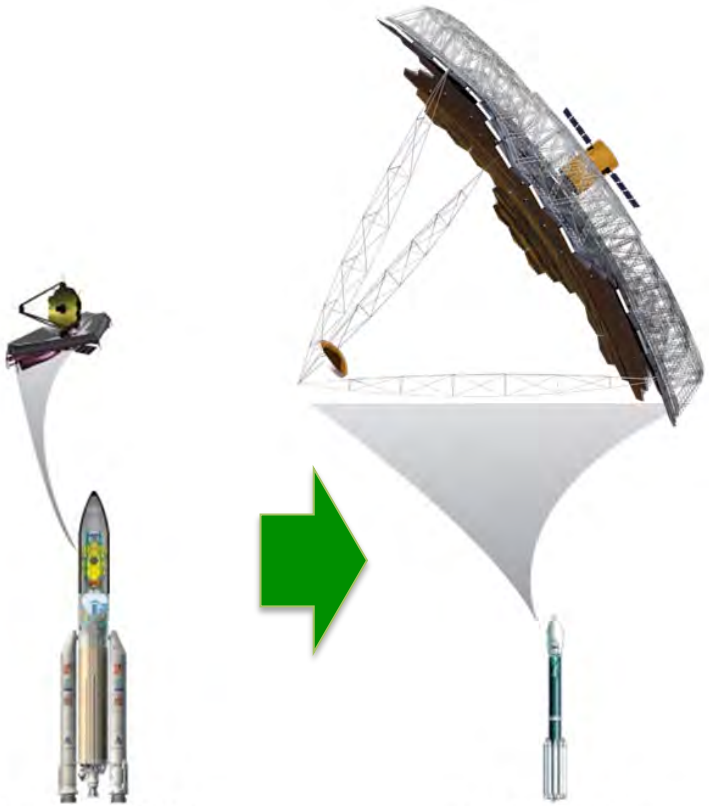
In-Space Manufacturing Value Proposition

NIAC NASA Innovative Advanced Concepts

Tethers Unlimited — Transformative Technologies for Space, Sea, Earth, & Air

Enables Lower Life Cycle Cost and Higher Performance

Status-Quo:
Satellite Capability Limited by Rocket Shroud Volume

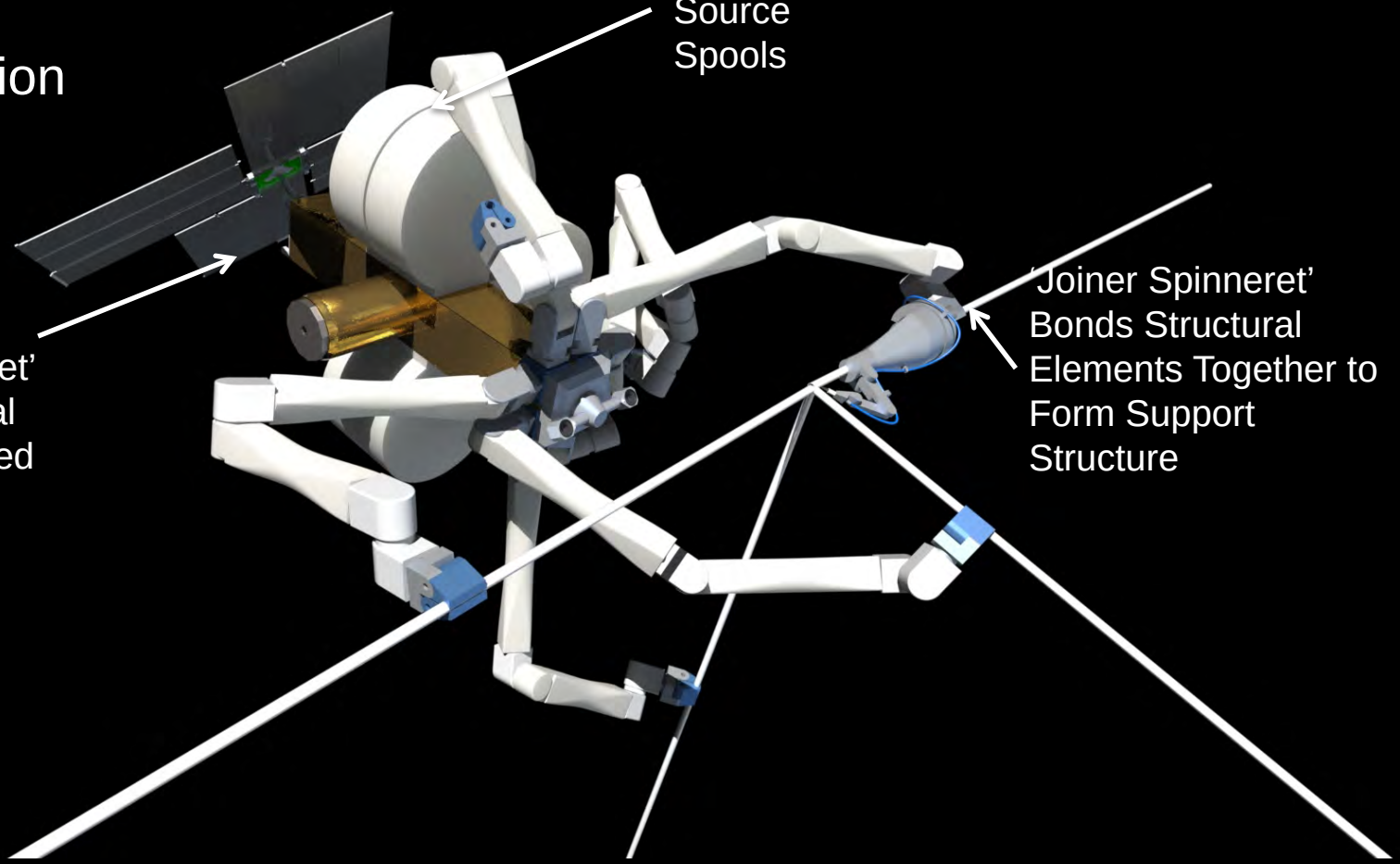


SpiderFab:
In-Space Additive Manufacture Escapes Volumetric Limitations to Enable Higher-Performance and Lower Launch Costs

SpiderFab™

Need the 4M's:

- Manufacturing
- Mobility
- Manipulation
- Metrology



TUI Developing Robust Space A.M. Ecosystem

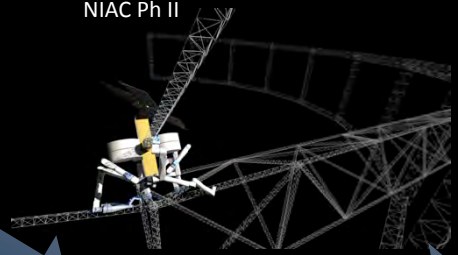
Tethers Unlimited
Transformative Technologies for Space, Sea, Earth, & Air

ISRU A.M. Materials
TUI IR&D

ISRU Basalt Fiber

Trusselator
NASA/LaRC SBIR

SpiderFab
NIAC Ph II



Positrusion Recycler
NASA/MSFC SBIR

CRISSP Recyclable Launch Packaging
NASA/MSFC SBIR

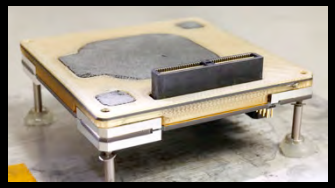
KRAKEN Arm
NRL Seedling

Trusses

Pressure Vessels

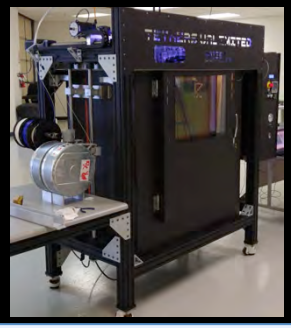
Structural-MLI
DARPA Ph I SBIR

Versatile Structural Radiation Shielding
AFRL SBIR



Optimized Additive Manufacturing for High Dielectric Strength
AFRL STTR

Matter Compiler
Multimaterial 3D Printer
TUI IR&D



Long-term goal is to enable use of *in-situ* resources to construct infrastructure in space to support robust exploration, utilization, & settlement of the solar system

Constructable™ Antennas and Sensors

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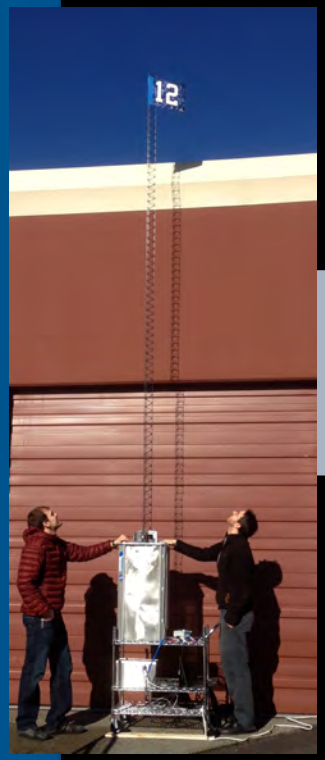
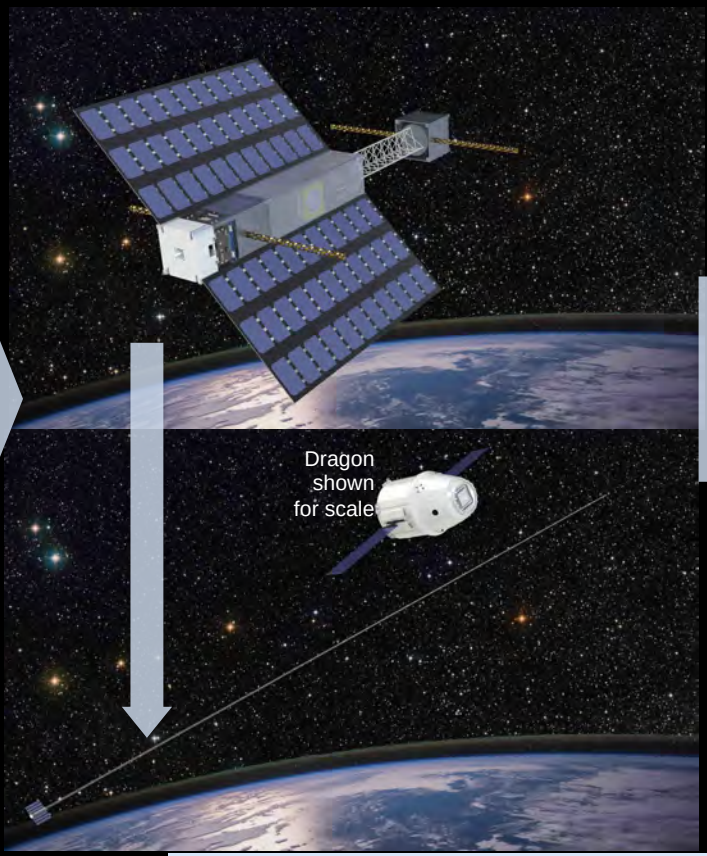
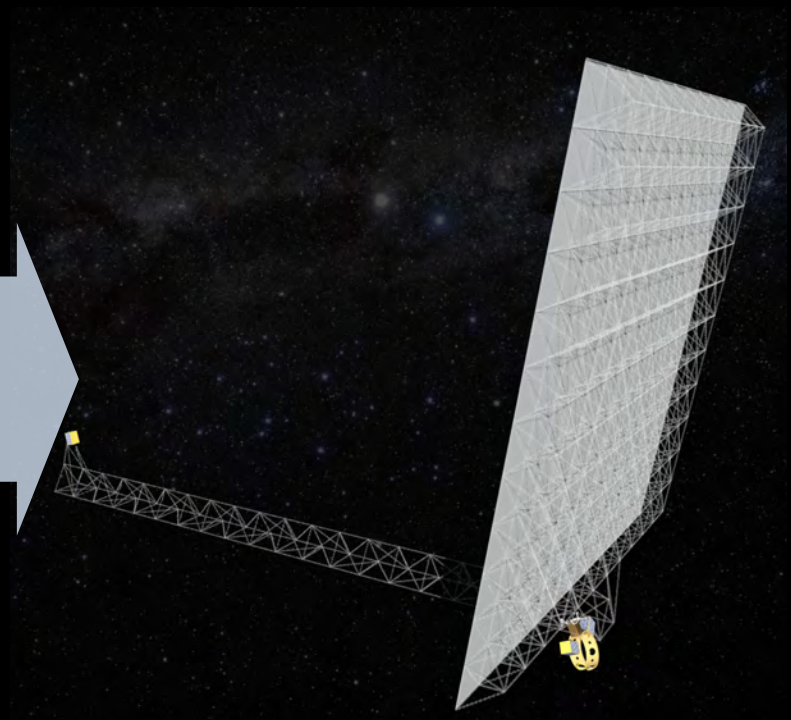


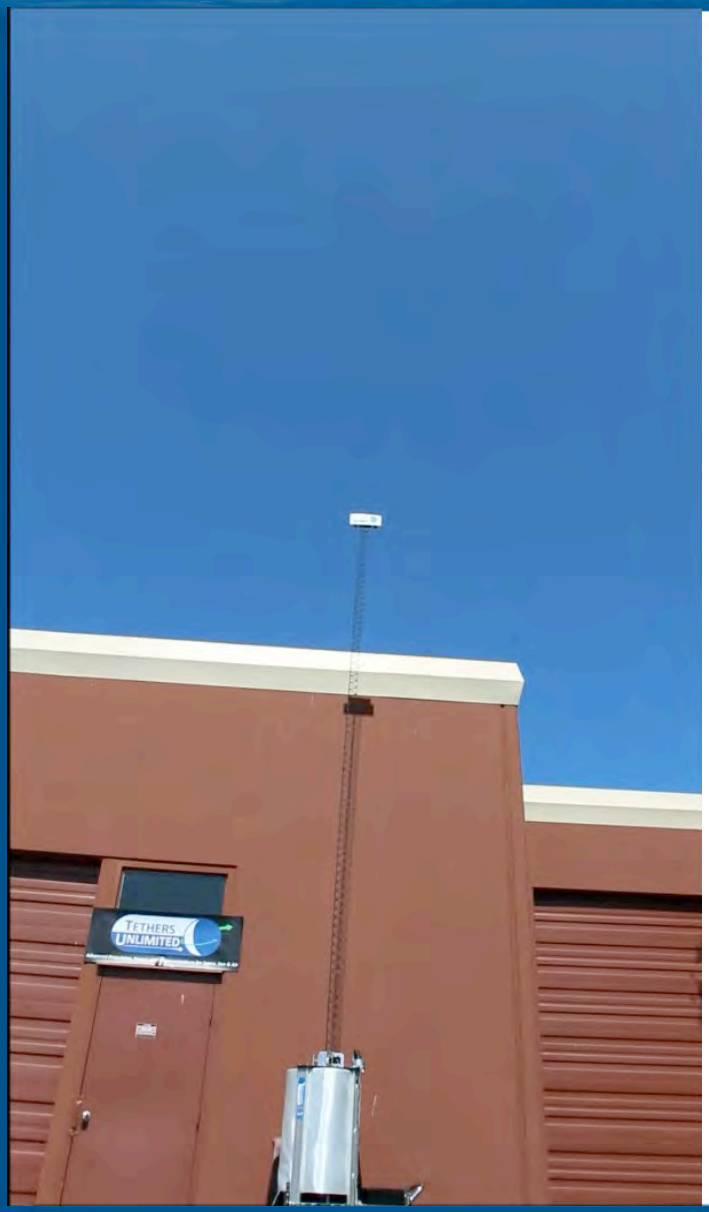


1. Long-Baseline Sensors

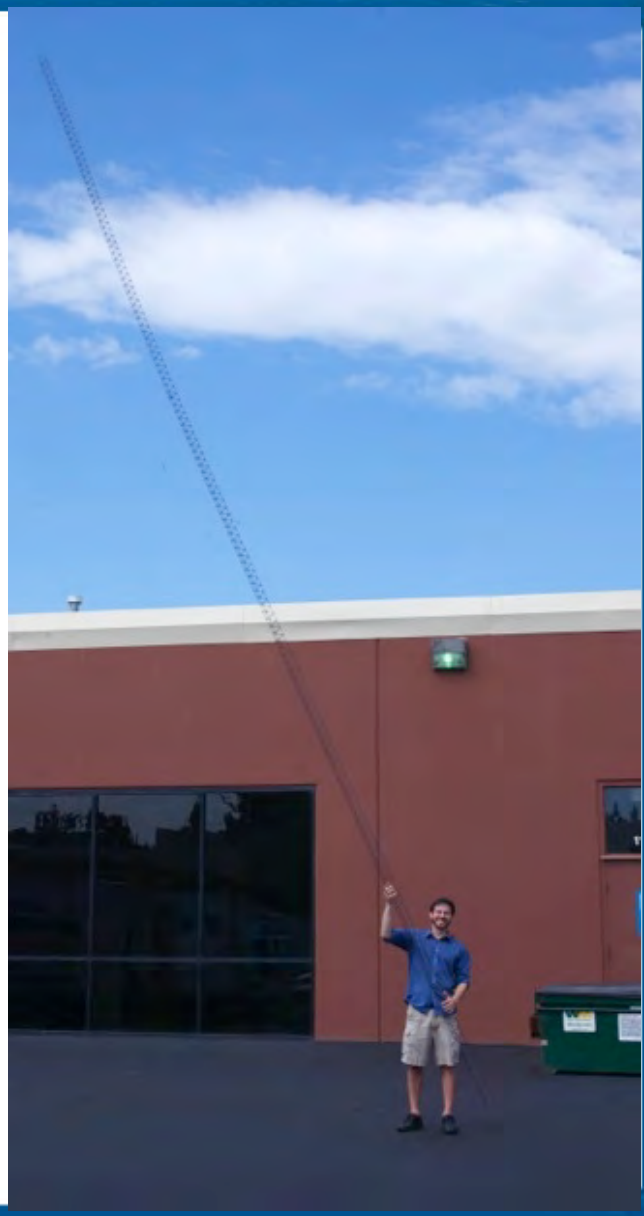


2. Large Antennas for SATCOM and SIGINT

Long Truss Demo – Ph I Prototype



- Using the Trusselator Phase I prototype we made several lengths of first-order truss
- Longest sample was 10 meters long and weighed 340 grams
- Forming the 10m truss took approximately 3 hr
  ~5 cm/min

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Truss of Trusses Demo