NC STATE UNIVERSITY | Mechanical and Aerospace Engineering

H.A.M.S.T.I.R.

High Amplitude Moon Surface Telecommunication Inflatable Repeater

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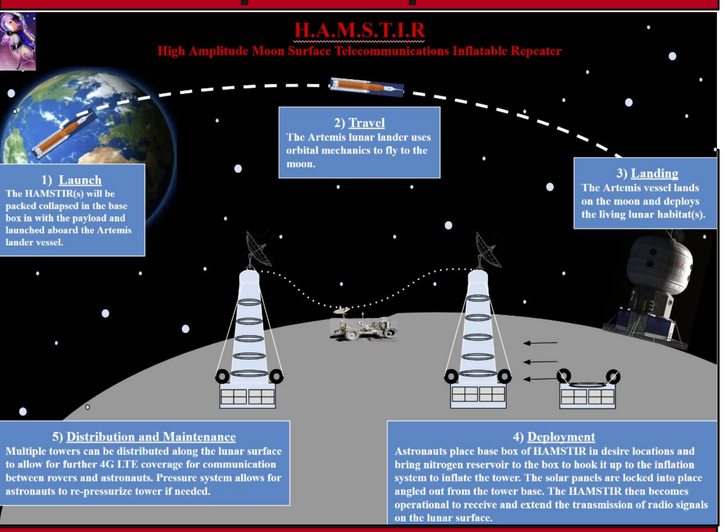
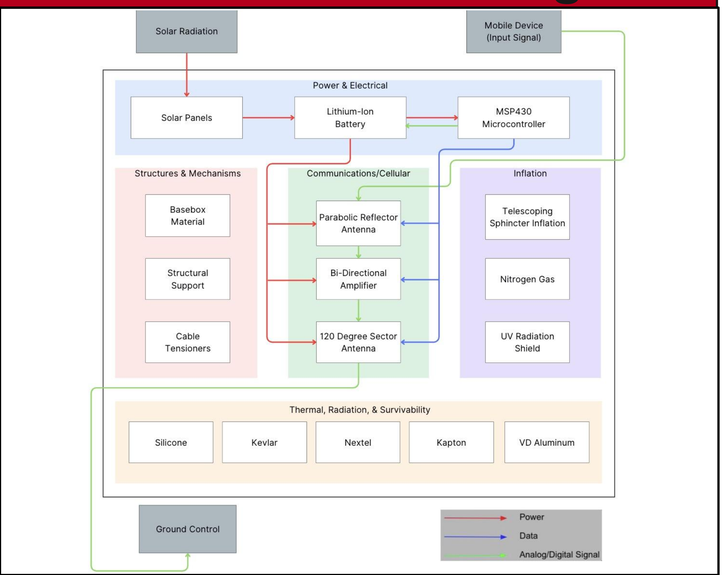
Project Overview

HAMSTIR is an inflatable, solar-powered 4G communications tower that deploys on the lunar surface from a compact basebox using sequential nitrogen inflation and internal rigid supports. It enables a widespread data network essential for communication between astronauts and rovers for future lunar exploration while minimizing payload mass and volume.

Concept of Operations

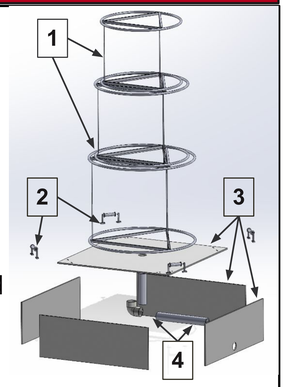


Functional Block Diagram



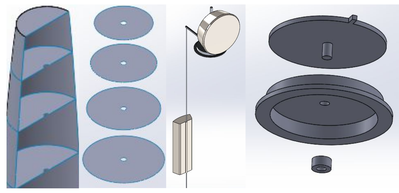
CAD Models

1. **Triangular-Ring Slot-Truss Structure:**
   - Slotted poles extend during inflation and lock into place, providing structural stability
2. **Tensioner Spools:**
   - Spools attached to basebox with wires that connect to top of tower and provide tension for structural stability
3. **Base-Box Sides and Lid:**
   - Basebox houses electrical components and air intake system and supports tower
4. **PVC Inflation Pipe System:**
   - Facilitates airflow from the air tank to the inflatable bladder



Also included:

- **Inflatable Bladder and Sphincters:**
  - Allows for sectional inflation
  - Materials: vinyl , silicone
- **Kevlar Protective Layer:**
  - Intended to protect inflatable bladder
  - Layers: Silicone, Kevlar, Nextel, Kapton, Vapor-Deposited Aluminum
- **Air Tank:**
  - Used to inflate the bladder system
  - Prototype: 125 psi air tank ; Full-Scale: liquid nitrogen
- **Communications Equipment and Mount:**
  - Prototype: Wifi-extender and rotating bearing mount
  - Full-Scale: Parabolic and sector antenna w/ rotating mount system



Manufacturing

Mount & Antenna:

- 3D printed rotating bearing mount & parabolic antenna
  - Secured mount to kevlar w/ zip ties, repeater w/ plastic cement

Basebox:

- Manufactured with plexiglass
- Solar panels mounted to exterior using bolts
- Battery packs & power inverter mounted to interior

Truss Structure:

- 3D Printed PLA and ABS Triangular-Ring Slot-Truss Structure

Bladder:

- Bladder manufactured with vinyl; fit directly to tri-slot & surrounded by kevlar protective layer

Final Prototype

Communications:

- TP-Link AC1900 Wifi-repeater (2/4/5.0GHz) wired to batteries
  - Configured to NCSU guest network (70ft coverage extension)

Power and Electrical:

- 7.5W solar panels generate additional power to recharge the 5.2Ah Li-ion battery packs, which are configured to a 12V to 110V DC to AC power inverter.

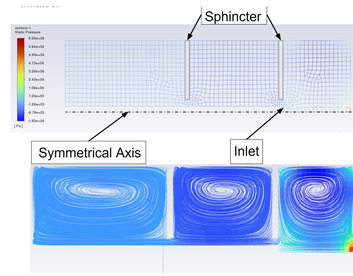
Structures and Mechanisms:

- .5 inch diameter ring and interior pole thickness
- 24 inch interior ring diameter with accordingly fitted equilateral tri-slot
  - Results in 20.76 inch pole lengths
- Pole ends are .2 inches thick to fit within rails
  - Top end is mushroom shaped to support sliding in the rail
  - Bottom end is a .18 inch diameter circle with a 1/16 inch hole to allow for a pin connection and enable rotation

Testing and Results

Inflation System:

- CFD ANSYS tests for sectional inflation
  - Sectional vortices encourage systemic inflation
- Decreasing pressure through mesh from top to bottom



Structures and Mechanisms:

- FEA ANSYS analysis
  - 6.5 kg load under Earth conditions
  - Max deformation of 7.5mm in top section
    - ANSYS deformation is cumulative, successful simulation
  - Max stress of 2.6E6 Pa
  - Simulation did not account for torsion in the poles, but this issue was accounted for with the bladder constriction and “lego hand” prints

Communications and Power:

- Simulated vertical antenna isolation distance (>6ft), coverage extension range (~1.4km for -110 dBm), and moment balance
- Batteries charged by solar panels and wired up to repeater to provide ~12V of continuous power for 4+ hours