National Aeronautics and Space Administration

Enabling Higher Data Rates With A New Generation Of Higher Frequency Antennas

Principal Investigator: Samuel Case Bradford (355)

Dan Kahn (355), Greg Agnes (355), Mehran Mobrem (355), Lee Peterson (35), Gary Wang (355), David Bell (337)

Program: Strategic Initiative

Objective: Develop a mission architecture that will enable 10x to 100x the data rates of current outer planet communication systems.

1. **Evaluate RFI responses and define a follow-on effort for Year 3.**

In Year 1 of this effort we investigated commercially-available mesh antenna systems. Relative to the state of the art the implied antenna characteristics for an **order of magnitude (10dB) increase in gain** are at least **5 m diameter** and operational at **Ka band**.

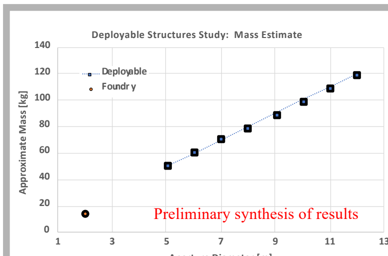
Several commercially-available mesh antenna systems meet one criteria of A) Ka-band or B) >5m diameter. Our team issued a study contract to multiple vendors for the purpose of incorporating a COTS mesh system into an outer planet mission, and creating a synthesized prediction of mass/performance/cost at multiple sizes. This involved preliminary gain budgets and thermal/structural/performance modeling.

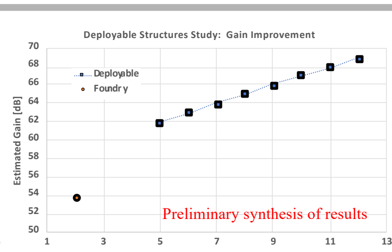
Results: Commercially-available COTS systems can be suitable for outer planet missions with modest modifications.

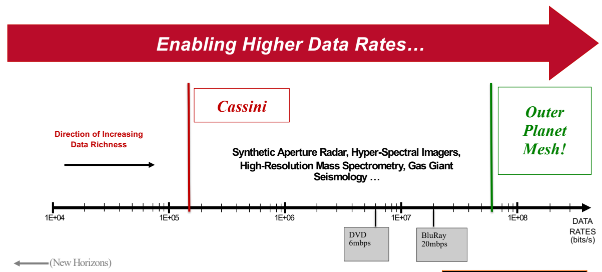
The Year 1 study with multiple vendors found no obstacles to extending earth-orbiting TRL-9 mesh antenna architectures to an outer planet environment. Under this study the teams investigated thermal distortion under operational conditions, and also transient events including: orbital insertion and Venus flyby. In Year 2 it was determined that in all cases the proposed architectures were broadly compatible with the allocated stowed volume, mass, stability, and power allocations. The next steps for this team are to coordinate with the JPL Foundry and generate a synthesis of all the information, including cost, that will be required for further formulation activities.

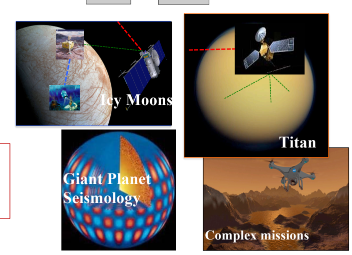
Portions of the Year 2 objectives were delayed to Year 3 to accommodate staffing availability, in Year 3 the remaining tasks include a series of briefings internal to JPL and a follow-on series of industry meetings to discuss effective partnering strategies.

Follow on activities also include a JPL-led sensitivity study to assess the link budgets for hypothetical outer planet missions. As shown above and at right, the improved gain of a deployable mesh antenna requires the allocation of significant mass and volume. While the inherent advantage of a 10X or 100X increase in data rates seems compelling, a full assessment of mission architectures is still required. And finally, no discussion of competing architectures would be complete without a discussion of costs.





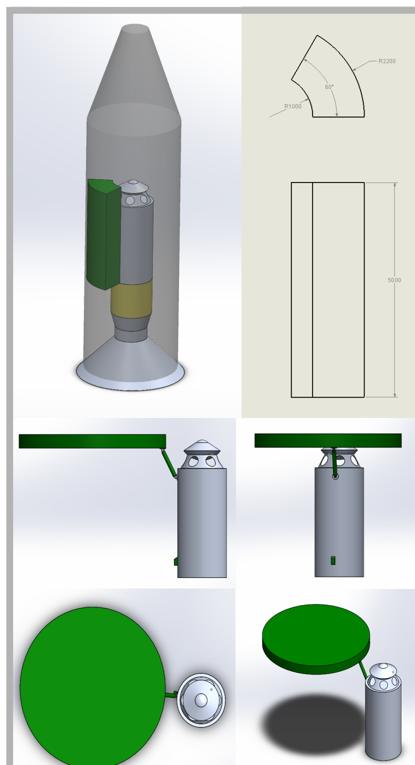




JPL should be designing 21st Century missions with modern data rates.

Proposed near-term solution: large RF aperture operating at Ka band

Above: Data generated by deep space missions has increased by an order of magnitude every decade. A notional data set of 12GByte for a gas giant seismology mission would take a week to downlink to Earth using Cassini data rates. At Uranus distance, 2x farther = 4x slower, it would take a full month to retrieve the data. We are developing a large mesh reflector system that can download the same amount in 7 hours. (New Horizons, from Pluto, at 1kb/second is offscreen to the left of this chart and at these rates it took ~16 **months** to download 10s of GB of data.) Figure credit: Joe Lazio et al.
Below left: JPL Foundry mass and gain inputs for a 2m aperture, compared with commercial mesh antenna systems. Gain and mass estimates are very sensitive to the assumptions used for the systems and consequently we are marking them as preliminary.
Below right: Cartoon showing notional geometry for stowed and deployed mesh antenna system.



National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

PI/Task Mgr. Contact Info: x3.2793, case at jpl.nasa.gov

Poster #: RPC-258