Prioritized Technology: High Bandwidth, High Data Rate Communications
Large Deployable Reflectors and High Power TWTs

Technical Goal

Low-mass, large diameter reflector to enable high data rate communications. High efficiency (>60%) Ka-Band antenna with
X-band capability– minimum configuration would be X-band uplink and Ka-band downlink.
Assuming a 75 W traveling wave tube at Mars Perigee and Jupiter:

- Class 1: 3.5 m diameter dish: ~120 Mbps (Mars) / ~1 Mbps (Jupiter)
- Class 2: 4.0 m diameter dish: ~160 Mbps / ~2 Mbps
- Class 3: 5.2 m diameter dish: ~270 Mbps / ~3 Mbps
- Class 4: 7.0 m diameter dish: ~490 Mbps / ~6 Mbps

Mission Applications

- Mission modeling indicates desire for ~10X data improvement per decade from the DSN through 2040.[1] Less than 5% of Mars surface has been mapped with high resolution.
- Ka-band offers 4X improvement over X-band, and Ka-band transmission enables high data rates from multiple missions with existing Earth stations. Cost estimate of 12 m optical receivers is $125M each.
- For outer planets missions, which are typically power limited, flying a larger antenna is the only spacecraft-based RF solution to increasing the data rate
- With more power-rich missions in the inner solar system, a large antenna can greatly increase the data rate. Data rates scale as antenna diameter *squared.*
- Class 1: HiRise camera data from MRO could be relayed in real-time
- Class 2: Future mission requirement for Earth science mm-wave radiometery missions (per ESTO).
- Class 3: Optical-equivalent dates from Mars and Jupiter
- Class 4: Current MRO-equivalent peak data rate from Europa

Technical Status

- The HiRise camera on MRO generated 120 MBPS but only delivered a data rate of 0.5 to 6 MBPS peak, limited by the diameter of MRO's rigid antenna (3 m) and power.
- Rigid antenna diameters are limited by launch vehicle shroud volume to 3 or 4 m. MRO's antenna had an aerial density of 3.1 kg/m^2
- Commercial space routinely flies large diameter deployable mesh reflectors but typically for L and S bands
- TDRS K/L/M are flying a ~5 m deployable mesh reflector for S, Ku and Ka bands (areal density TBS)
- A 5.2 m deployable mesh reflector, with an areal density of 0.8 kg/m^2, and demonstrated 60% efficiency at Ka-band has been demonstrated on the ground.
- 200 W Ka-band TWTs with > 60% efficiency exist
- Deep-space optical communications risks have not been retired by recent near-Earth demonstrations.

Development Cost and Schedule

[1] "Deep Space Network: The Next 50 Years," Dr. Les Deutsch, Dr. Steve Townes, August 10, 2016