NASA SBIR 2005 Phase I Solicitation

O1.04 Antenna Technology

Lead Center: GRC

Participating Center(s): GSFC, JPL, JSC, MSFC

NASA seeks advanced antenna systems for use in spacecraft and planetary surface vehicles used in science, exploration systems, and space operations missions. Future manned missions to the Moon and Mars will have stringent communication requirements. Highly robust communication networks will be established in the vicinity of the planet to support long-term human interplanetary mission. Such networks will consist of a large number of communication links that connect the various network nodes. Some of these nodes must also maintain continuous high data rate communication links between the Moon and the Earth. Great demands will be placed upon these communication systems to assure crew safety, robustness in harsh environments, and high reliability for long-duration manned missions.

Areas of interest include lightweight deployable antenna systems, high-gain antenna architectures, multi-frequency and dual polarized antennas, self-orienting systems, reconfigurable antennas, and novel concepts such as antennas that can adapt to failed components without compromising performance and operability (e.g., smart antennas). NASA seeks to develop a lightweight, scanning, phased array antenna system that enables assured communication links for human interplanetary exploration.

Large inflatable membrane antennas to significantly reduce stowage volume, provide high deployment reliability, and significantly reduced mass (i.e.

High efficiency, miniature antennas with smaller than lambda square aperture size, to provide astronauts and robotics communications for surface-to-surface and surface-to-orbit for lunar, Mars, and planetary exploration missions. Recent antenna research and development has shown that it is possible to design and build aperture antennas with smaller than the minimum effective aperture sizes of dipoles. This new class of antennas can provide higher antenna gains (>2.5 dBi) than a dipole antenna in much smaller aperture sizes ( \[ \text{Page 1 of 2} \] )

The architecture for lunar exploration is expected to involve a layered communications and navigation network. This network may include lunar vicinity relay satellites at L1 and L2 Lagrange points as well as lunar polar orbiting satellites. The lunar proximity network must be able to access dedicated assets, such as Malapert Station, and eventually include human assets, such as crewed rovers, as relay nodes. Consequently, there is interest in antenna technologies that enable low-cost but reliable, reconfigurable, and agile antennas at frequencies up to 38 GHz. Another component technology that shows high interest in the area of Earth and planet science is thin-membrane, mountable T/R modules, phase shifters, beam former, control circuitry, etc. for future deployable/inflatable, large-aperture, phased array application. This topic seeks novel smart antenna concepts that address the aforementioned requirements.

There is also interest in space-to-surface links at 25.5 GHz and 37 GHz. The size of reflector antennas is limited by the accuracy of the reflector surface that can be achieved and maintained on-orbit. Development of special materials and structural techniques to control their environment, etc., reduces environmentally-induced surface errors and increases the maximum useable reflector size. Distortions caused by thermal gradients are inherently a large-scale phenomenon. The reflector surface is usually sufficiently accurate over substantially large local areas but these areas are not on the same desired parabolic surface. An array of feed elements can be designed to
illuminate the reflector with a distorted spherical wave. This distortion can be used to compensate for large-scale surface errors induced by thermal gradients, gravitational and other forces, and manufacturing processes. Topics of interest include, but are not limited to: compensating feed system for an antenna reflector surface with large-scale distortions; techniques for the remote measurement of satellite antenna profile errors; determination of orbiting S/C antenna distortion by ground-based measurements; measuring and compensating antenna thermal distortions; reflector measurements and corrections using arrays; reflector distortion measurement and compensation using array feeds.

NASA is interested in low-cost phased array antennas for suborbital vehicles such as sounding rockets, balloons, UAV's, and expendable vehicles. The frequencies of interest are S band, Ku band, and Ka band. The arrays are required to be aerodynamic in shape for the sounding rockets, UAVs, and expendable platforms. The balloon vehicles primarily communicate with TDRS and can tolerate a wide range of mechanical dimensions.

Finally, antenna pointing techniques and technologies for Ka-band spacecraft antennas that can provide spacecraft knowledge with sub-milliradian precision (e.g.,