NASA Technology Summary

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

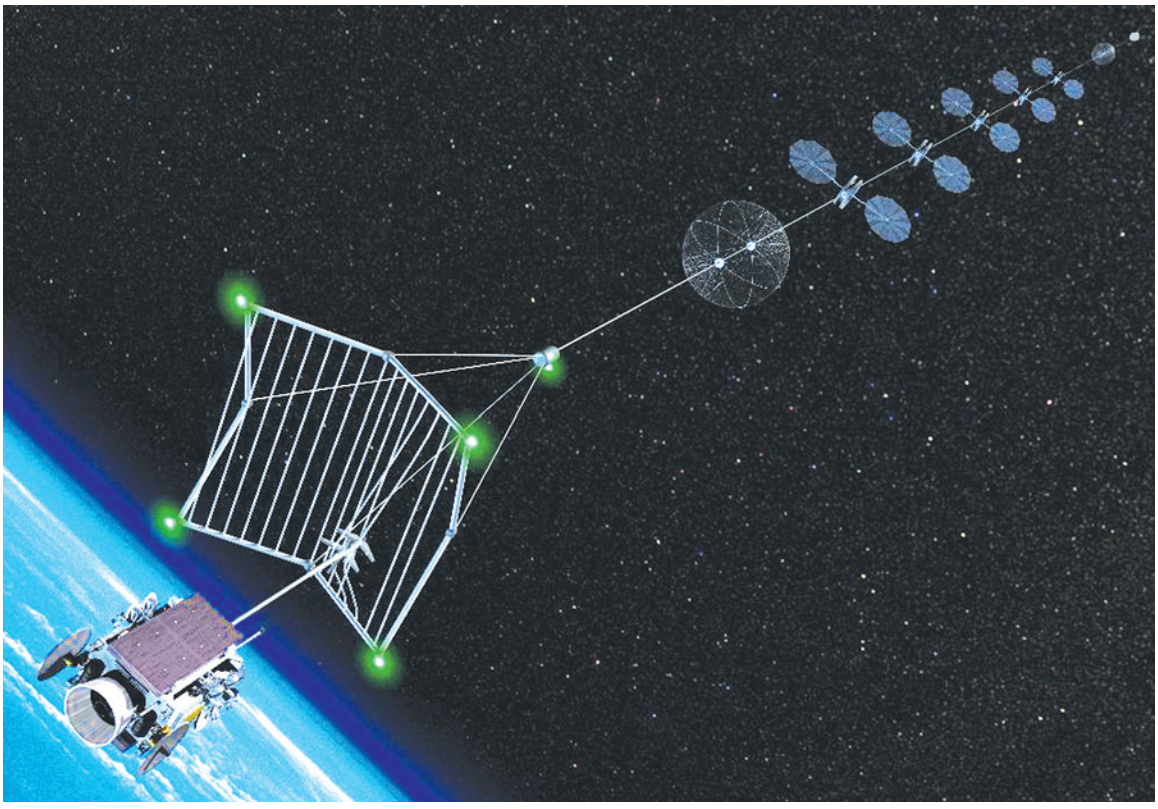
In-Space Propulsion

Momentum-Exchange Electrodynamic Reboost (MXER) Tether

NASA's In-Space Propulsion Technology Program is developing experiments to demonstrate tether-based propulsion—which draws power from the Sun and uses the magnetic field surrounding the Earth to propel spacecraft without the use of on-board propellant. The innovative technology could dramatically reduce the cost of raising the orbits of other spacecraft, including those destined for deep-space missions.

Momentum-exchange tether propulsion transfers momentum from one object to another by briefly linking a slow-moving object with a faster one. Much the same way ice skaters play "crack the whip," the slower object's speed could be dramatically increased as momentum and energy is transferred to it from the faster object. Similarly, a spinning tether facility in an elliptical Earth orbit might snare slower-moving spacecraft in low-Earth orbit and throw them into much higher-energy orbits.

NASA researchers currently are developing the technologies needed to realize this advanced form of propulsion. The "Momentum-Exchange Electro-



dynamic Reboost" tether propulsion system, or MXER tether, could use momentum-exchange to transfer satellites from low-Earth orbit to geosynchronous transfer orbit—an elliptical orbit stretching from 200 miles out to 22,300 miles above the equator —and beyond. After throwing the payload, the MXER tether would then use energy collected from solar panels to drive electrical current through the tether. The Earth's magnetic field would push against the current and reboost the tether's orbit, restoring the energy that was transferred to the payload.

Once launched to low-Earth orbit by a rocket, the MXER tether system is intended to deploy a tether roughly 100 to 150 kilometers (62 to 93 miles) in length. This tether would be made of lightweight, high-strength material, coated for protection from the space environment. Part of the tether would also incorporate an insulated conductive material, like aluminum, to carry the electrical current needed to reboost the tether.

Payloads bound for high-Earth or escape orbits, such as communications satellites and interplanetary spacecraft, would be launched by rocket to low-Earth orbit. There, they would rendezvous with the tip of the spinning MXER tether, which would "snare" them via a net-like catch mechanism, then throw them toward their final destination. The process would eliminate or reduce the need for the upper-stage booster rocket usually associated with these high-energy orbits. And because the MXER tether could reboost its own orbit without propellant, it could repeat its orbital transfer duties for the duration of its lifespan. Also, since the need for an expendable upper-stage rocket—normally used only once—is eliminated or reduced, this capability would mean smaller, less expensive rockets could be used to launch the payloads.

All these capabilities make MXER tether technology extremely beneficial to NASA's space science missions. The tether system could tremendously enhance most current and future launch missions, becoming an economical "gateway to space"—much as the Panama Canal serves today as a passageway from the Atlantic to the Pacific for ocean shipping.

NASA researchers are already studying ways to expand the technology's potential, such as also deploying a tether into orbit around the Moon. This two-tether system—one in orbit around the Earth and the other around the Moon—could enable cheap, efficient two-way transport of payloads to and from the surface of the Moon, paving the way for future utilization of lunar resources and permanent human colonization, as well as robotic journeys to Mars and the outer planets.

NASA's MXER tether technology development team presently includes Tennessee Technological University in Cookeville, Tenn.; Lockheed Martin Astronautics in Denver, Colo.; and Tethers Unlimited of Lynnwood, Wash. Several other organizations and businesses are expected to join in the near future.

MXER tether technology is being developed by the In-Space Propulsion Technology Program, which is managed by NASA's Science Mission Directorate in Washington and implemented by the In-Space Propulsion Technology Office at Marshall Space Flight Center in Huntsville, Ala. The program objective is to develop in-space propulsion technologies that can enable or benefit near and mid-term NASA space science missions by significantly reducing cost, mass and travel times. NASA fuels discoveries that make the world smarter, healthier and safer.

For more information about NASA's Space Transportation Systems, visit:
http://www.nasa.gov

For more information about the In-Space Propulsion Technology Program, visit:
http://inspacepropulsion.com

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