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Author: Dr. Andrew Meulenberg
Universiti Sains Malaysia, Malaysia

FIBER-OPTIC, LEO-BASED, COMMUNICATIONS RING

Abstract

This paper develops the concept of a low-earth-orbit-based optic-fiber-communication system that may ameliorate some problems with present space communications systems. Starting with an assumption that a circum-terra ring can be deployed in LEO, a high-bandwidth, optical-fiber-based, communication system has been proposed, as the first of a number of LEO and MEO rings for different purposes, that would complement existing terrestrial and space networks and thereby improve global connectivity and throughput.

The experimental stage of a LEO-ring system (prior to deployment of the full fiber-optic ring) would involve testing and development of the control and stability of LEO-ring structures and of ring-based space-elevator, solar-power, and communication systems. The initial operational phase of the communication system would be LEO deployment of a near-equatorial, "circum-terra," optic fiber. The LEO-earth connection would be through microwave phased-array antennas with interconnectivity between the numerous ring-mounted mini-broadcast stations via the optic fiber. The inter-station optic-fiber links are far superior to any laser or microwave inter-satellite links (ISLs). The transmit/receive sub-systems are stabilized by, and powered from, the ring. Solar power is the logical source since solar-cell arrays can also become solar sails for station keeping. Electrodynamic tethers would be used to "spin up" the ring as a means of storing the converted solar energy. These same tethers would be used to draw energy from the ring as electrical power for the sub-systems when they are in the Earth's shadow and to provide additional propulsion for the ring for when/if the solar arrays/sails are inadequate.

The communication system would grow with the successive deployment of inclined-orbit rings above fixed ground points (higher-LEO, earth-synchronous rings). Specific rings, catering for example to earthquake-prone regions like Japan or to highly-populated regions like cities in Japan, India, and China, would be such examples. Inter-ring connectivity could be with either high-Ka band or optical (laser) links. Eventually the system would expand to provide global connectivity with the high-throughput point-to-point overhead capability of optic-fiber links. Once appropriate techniques are established, the deployment, maintenance, and repair of rings for this communication system would be economical compared to that pertaining to trans-oceanic cables or GEO constellations (and would not exhibit the communications time-delay of the latter).

The advantages, options, and economics of the proposed LEO optic-fiber / microwave communication system over existing terrestrial- and space-communication systems (of similar functionality) are explored. In particular, networking issues necessary for both initial and expanded-ring system communications are addressed.