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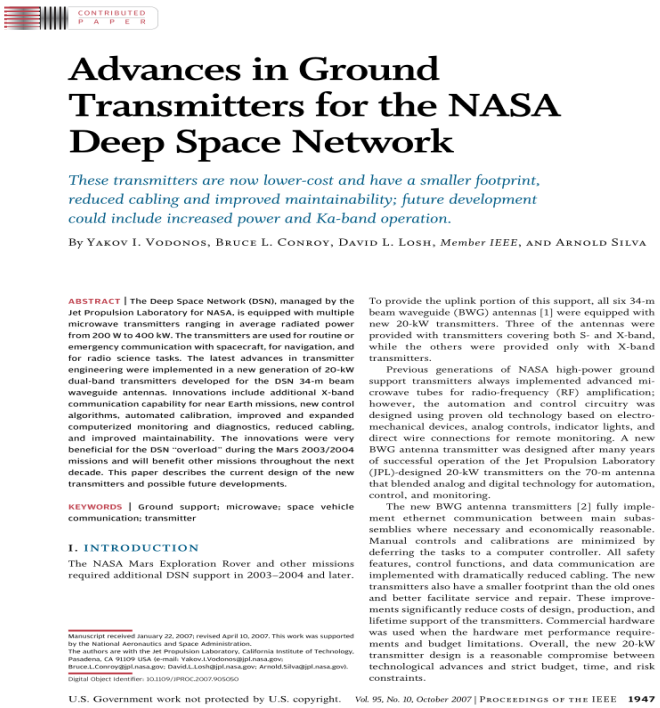

CONTRIBUTED PAPER

Advances in Ground Transmitters for the NASA Deep Space Network

These transmitters are now lower-cost and have a smaller footprint, reduced cabling and improved maintainability; future development could include increased power and Ka-band operation.

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ABSTRACT | The Deep Space Network (DSN), managed by the Jet Propulsion Laboratory for NASA, is equipped with multiple microwave transmitters ranging in average radiated power from 200 W to 400 kW. The transmitters are used for routine or emergency communication with spacecraft, for navigation, and for radio science tasks. The latest advances in transmitter engineering were implemented in a new generation of 20-kW dual-band transmitters developed for the DSN 34-m beam waveguide antennas. Innovations include additional X-band communication capability for near Earth missions, new control algorithms, automated calibration, improved and expanded computerized monitoring and diagnostics, reduced cabling, and improved maintainability. The innovations were very beneficial for the DSN "overload" during the Mars 2003/2004 missions and will benefit other missions throughout the next decade. This paper describes the current design of the new transmitters and possible future developments.

KEYWORDS | Ground support; microwave; space vehicle communication; transmitter

I. INTRODUCTION

The NASA Mars Exploration Rover and other missions required additional DSN support in 2003–2004 and later. To provide the uplink portion of this support, all six 34-m beam waveguide (BWG) antennas [1] were equipped with new 20-kW transmitters. Three of the antennas were provided with transmitters covering both S- and X-band, while the others were provided only with X-band transmitters.

Previous generations of NASA high-power ground support transmitters always implemented advanced microwave tubes for radio-frequency (RF) amplification; however, the automation and control circuitry was designed using proven old technology based on electromechanical devices, analog controls, indicator lights, and direct wire connections for remote monitoring. A new BWG antenna transmitter was designed after many years of successful operation of the Jet Propulsion Laboratory (JPL)-designed 20-kW transmitters on the 70-m antenna that blended analog and digital technology for automation, control, and monitoring.

The new BWG antenna transmitters [2] fully implement ethernet communication between main subassemblies where necessary and economically reasonable. Manual controls and calibrations are minimized by deferring the tasks to a computer controller. All safety features, control functions, and data communication are implemented with dramatically reduced cabling. The new transmitters also have a smaller footprint than the old ones and better facilitate service and repair. These improvements significantly reduce costs of design, production, and lifetime support of the transmitters. Commercial hardware was used when the hardware met performance requirements and budget limitations. Overall, the new 20-kW transmitter design is a reasonable compromise between technological advances and strict budget, time, and risk constraints.

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