Introduction to This Special Issue on Array Developments in the Deep Space Network

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The Deep Space Network (DSN) is facing a challenge of supporting the many future demanding missions that NASA plans for the next 25 years in a cost-effective manner. To this end, NASA Headquarters and the Interplanetary Network Directorate (IND) have commissioned studies of how best to increase the DSN capability, not simply by many factors, but by orders of magnitude. Options included ground-based radio frequency (RF) and either ground-based or orbital optical communication systems. One promising architecture for future RF communications leverages the technologies being developed by the radio astronomy community—arrays of a large number of small antennas. Recent developments by the privately funded Allen Telescope Array (ATA) and both the international and U.S. groups proposing a large array with a square kilometer of collecting aperture suggest that such a capability may be implemented, operated, and maintained for a fraction of the cost of the comparable functioning monolithic single aperture. These developments include advances in both electronics and manufacturing. During the past 2 years, we have investigated how an array-based capability could be implemented in the DSN, paying particular attention to both implementation and operations costs.

This special issue of *The Interplanetary Network Progress Report* provides a summary of many of the areas under study. Starting with a description of the science applications of the array (Jones and Connally), we lay the foundation for making a clear science case to migrate the DSN to arrays. A general summary of the array concept (Gatti), a more detailed architecture description (Bagri), and the considerations and options for configurations of the antenna elements (Jones) follow. Given an array and the location/configuration of its elements, one must calibrate the phases and amplitudes of the elements for optimal combining. Calibration in the presence of atmospheric turbulence (Bagri) is presented, from which we can iterate with the configuration modeling to achieve the right balance between the two. We then delve more deeply into specific technical areas, including the optics design for the breadboard antennas (Imbriale and Abraham) and a description of a breadboard antenna currently in development (Imbriale et al.) as well as a new multiple-frequency wideband feed (Hoppe and Reilly) and a novel cryogenic low-noise amplifier system (Britcliffe et al.). Next we describe the current plans for combining the many signals in a digital signal processing system (Navarro and Bunton), and to wrap up the technical studies, we describe the servo control system design for the breadboard antennas (Gawronski and Cooper) and a servo system test bed used to develop the pointing algorithms and controls (Cooper). Finally, a preliminary concept of operations is proposed that suggests new and unique ways to consider scheduling, operating, and maintaining such an array system (Bagri and Statman).

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This special issue is a collection of articles that represents a snapshot in time as to the concepts, plans, and designs that offer the possibility of increasing the DSN capability by orders of magnitude. The study period in which the current development has been done has come to an end. As of March 2004, the IND has created the DSN Microwave Array Project, charged with defining clear goals and expectations. Notwithstanding this, there is still much development to be done in order to complete the near-term goals of the new Project. Future articles appearing here and elsewhere will document those technical advances.