

Transforming the Deep Space Network into the Interplanetary Network

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For forty years NASA's Deep Space Network (DSN) has provided telecommunications and navigation services to nearly all US, and many international, deep space missions. This "24 hour-by-7 day" network has three complexes around the world that permit continuous coverage of solar system spacecraft and their critical mission events. But yesterday's missions and DSN, though noteworthy and successful, will give way to future concepts in space exploration. Already, new missions now in design, are targeting the challenging fundamental questions that confront space science. To enable these missions, NASA has demonstrated a commitment to removing the three main impediments to deep space exploration, namely limitations in power, propulsion and communications. In the area of communications, future mission requirements will stress the existing DSN, and, in fact exceed its capacity and capability. The sheer number of missions and mission elements is one factor. Common will be missions involving networks of orbiting and landed elements or vehicles flying in tightly controlled formations, all with increasingly complex and networked mission operations. Demand for bandwidth will grow, as new instruments with ever-increasing spatial, spectral and temporal resolution are developed and flown. During the last 15 years, the number of deep space missions has expanded fourfold while the number of deep space antennas has grown by only 33%. The resulting contention for tracking time directly limits mission data return. During the same time period, the mission set has evolved from one characterized mostly by individual spacecraft remote sensing to one having a significant amount of in-situ, networked operations, particularly at, though not limited to, Mars. Finally, assets of the DSN are aging, and with some of these dating back to the 1960s, reliability issues are being appropriately raised. Though the current DSN may be in need of upgrade, it nevertheless represents an excellent foundation for the building blocks that will occur.

To energize the necessary new initiative, an updated vision is developing. Formally, this can be stated as, "Enable telescience and telepresence throughout the Solar System and beyond," or more colloquially, "Bring the sensors to the scientists and the planets to the public." The goal is to transform the DSN into an Interplanetary Network that:

- Provides networked connectivity, wherever needed, across the Solar System – and beyond;
- Provides transparent communications, navigation, science and operations services to customers that enhance, rather than constrain, the accomplishment of their objectives
- Incorporates the latest technologies, as appropriate, to enable improved exploration and discovery;
- Provides readily available, secure and efficient information access to science and public users

Strategies for overcoming obstacles and meeting new requirements will be discussed. For communications these will include ongoing work to renovate and "complete" the foundational DSN; development of advanced spacecraft radios, amplifiers and antennas; prototyping of large arrays of small antennas; demonstration of optical communications; augmentation of the localized Mars Network infrastructure with a dedicated comsat, and; development of new end-to-end standards and protocols. For mission services these will include upgraded capabilities and tools for use in deep space navigation, network and multi-mission operations, mission design, and science and public applications. Effective use of this Interplanetary Network will be enabled by an appropriately layered information architecture and advanced developments in space information systems, reliable mission software and state-of-the-art access and processing capability. The entire initiative will be underpinned by a vigorous technology development activity.