Pioneer Mission Support

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Current status of the Pioneer 10 and 11 missions and Pioneer Venus 1978 mission is described.

I. Pioneer 10 and 11

The Pioneer 10 spacecraft is continuing to return data on new regions of the solar system never before explored by a man-made object. Pioneer 10 is continuing to be tracked daily by stations of the Deep Space Network (DSN).

In an effort to experimentally increase the range by which a DSN 26-m antenna can receive useful data from Pioneer 10, an R&D low-noise cone was installed at the Pioneer Station (DSS 11) at Goldstone. The result was an improvement of approximately 0.7 dB in performance. On October 4, 1975, an experimental 3-Hz loop was added to a receiver at the same station and has resulted in an additional (approximately 1-dB) improvement in performance. This configuration at DSS 11 will add several months of 26-m antenna coverage capability for Pioneer 10.

Starting in May 1975, an unexplained drifting of the spin axis of Pioneer 10 was observed. Several different theories were proposed, after a gas leak was eliminated as a possible cause, to explain this drift by unusual forces or radiation pressures in the region of the solar system the spacecraft had entered. It was finally discovered in July that, during a routine spacecraft orientation maneuver, the Pioneer 10 star sensor had shifted from the star Betelgeuse to Sirius, and therefore a twisting of the reference frame had caused an apparent drift northward instead of the natural east–west drift due to the relative Earth motion.

Pioneer 11 had experienced several occurrences of spurious commanding since its encounter with the planet Jupiter. Several of these incidences resulted in extensive analysis by the DSN to ensure that the spurious commands had not been transmitted by a Deep Space Station due to some kind of failure on the ground. A turn-off of all the science instruments with a staged turn-on seems to have isolated spurious commanding problems to some kind of failure associated with the asteroid–meteoroid detector. Pioneer 11 is now operating with that instrument turned off. The plasma analyzer has also apparently failed, although efforts are continuing to periodically activate the instrument. All other aspects of the Pioneer 11 spacecraft seem to be functioning normally.

A trajectory correction for the purpose of the Saturn encounter targeting is planned for December 17, 1975. Several Saturn encounter alternatives are still being debated, which include going inside or outside the rings, and a possible approach to the moon Titan.

Figure 1 is a plot of the received carrier power and bit rate for Pioneer 10 and 11 through 1979. This chart is an update by Network Operations Planning of a chart which was published in a previous Progress Report article.

II. Pioneer Venus

The Pioneer Venus program was threatened when FY-76 funds were cut by the House of Representatives. However, after two months, a Joint Congressional Committee restored essentially all funding, and the program is on course and schedule.

The Pioneer Venus multiprobe entry includes a differenced long baseline interferometry (DLBI) experiment which will attempt to measure the wind velocity on Venus as the four probes descend through the atmosphere. This experiment has been described in previous Progress Report articles (see in particular Ref. 1). Basically, the experiment will be using interferometry techniques to measure components of the velocity across the line-of-sight (Earth–spacecraft direction) and established doppler techniques to measure the velocity components along the line-of-sight. The interferometry technique involves receiving each probe signal simultaneously with the signal from the bus at several ground stations. As described in previous articles, the bus is retarded by a trajectory correction after it releases the probes, so that it enters the Venusian atmosphere after all four probes have reached the surface of the planet. In this way, the bus serves as a reference signal, undisturbed by the Venusian atmosphere. A corrected difference is taken between the bus signal and each of the probe signals at a particular station to eliminate ionospheric and interplanetary effects, and a second difference is taken between two stations which produces a measure of the angle subtended by the two stations and a probe, and the rate of change of that angle is the measure of the velocity of the probe perpendicular to the line-of-sight.

Each pair of stations resolves only one dimension of the velocity. The two 64-m DSN stations at Goldstone, California, and Canberra, Australia, are the primary stations for the multiprobe entry. However, if they were used alone, only one component of the wind perpendicular to the line-of-sight would be resolved. It was therefore necessary to locate at least one other station with an appropriate long baseline in or adjacent to the Pacific Basin in order to resolve all components of the wind. The experimenter had proposed a 26-m station in Kishima, Japan, which belongs to the Radio Research Laboratories branch of the Ministry of Posts and Telecommunications of Japan, and the 9-m station located near Santiago, Chile, which is a part of the Spaceflight Tracking and Data Network (STDN). When the Pioneer Project Office appealed to the Office of Space Science for guidance as to how to proceed in obtaining two non-DSN stations to support the DLBI experiment, the Office of Tracking and Data Acquisition (OTDA) recommended that only stations which were part of the NASA inventory should be considered for cost and reliability considerations. In particular, OTDA recommended the use of the STDN stations at Guam and at Santiago, Chile, and assigned the TDA office at JPL the responsibility of coordinating the Santiago and Guam support for the project. The resulting network for the DLBI is shown geographically in Fig. 2. Note that a fourth station is included for redundancy and closure.

Upon receipt of the direction from OTDA, negotiations were initiated between the DSN and STDN for the purpose of establishing the engineering and operational interfaces necessary for coordinating the engineering, implementation, and operation of the Santiago and Guam stations. A first meeting for coordination purposes was held at Goddard on June 3, 1975. Tentative agreement reached is that the STDN stations will utilize STDN low-noise amplifiers, receivers, and timing subsystems and that the STDN will provide the required down-converters to interface with the STDN receivers, as well as the method of calibrating the STDN stations. The DSN will provide the high-rate digital recorders and associated A to D converters and electronics for the STDN stations.

Reference

1. Miller, R. B., "Pioneer Venus 1978 Mission Support," in *The Deep Space Network Progress Report 42-27*, pp. 28–35, Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1975.

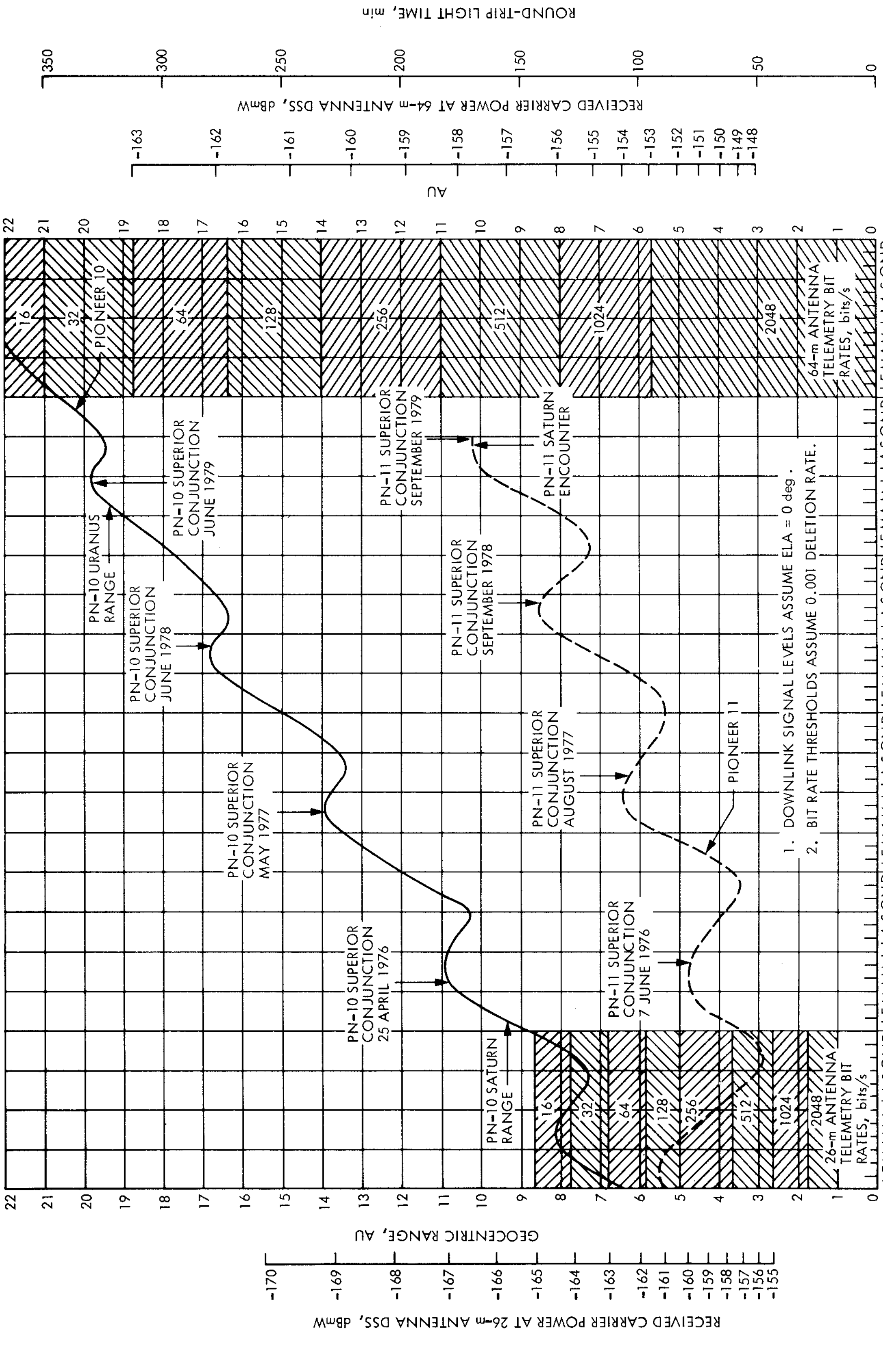

Fig. 1. Downlink performance estimates for Pioneers 10 and 11

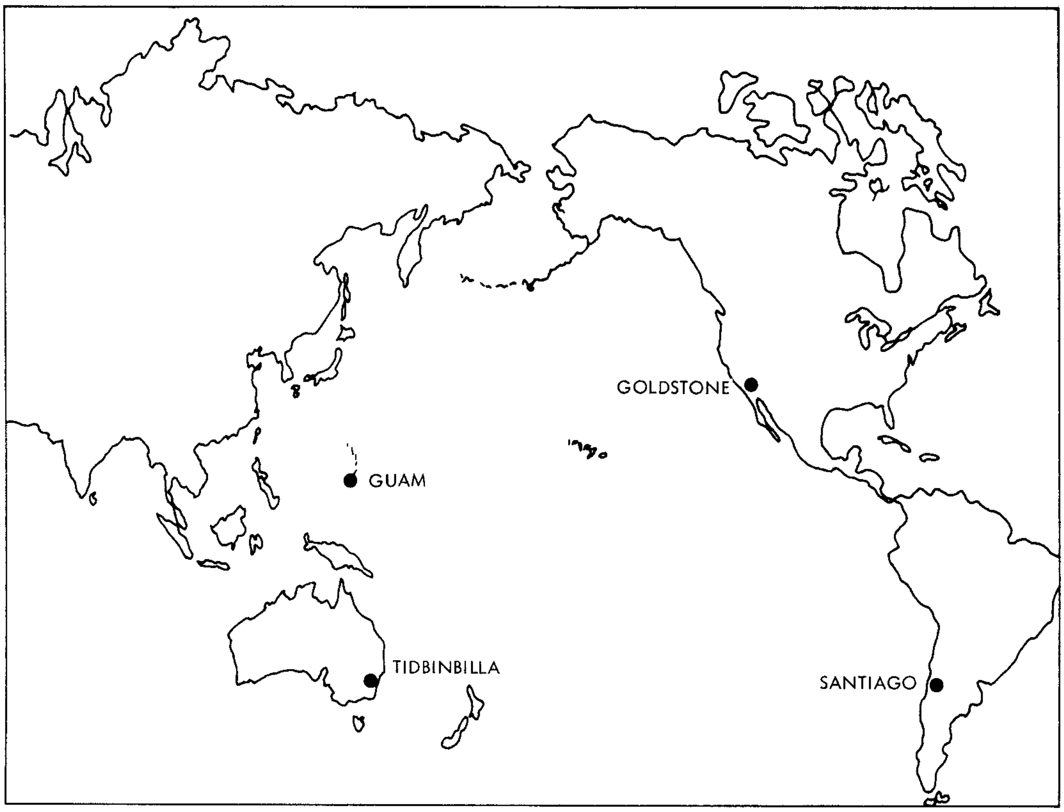

Fig. 2. Tracking stations supporting the Pioneer Venus DLBI experiment