Pioneer Venus Mission Support

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The Deep Space Network (DSN) has advanced capabilities which can be used for spaceflight missions to Venus. This presentation was given to the Pioneer Venus study team on the ranging and S/X-band systems, which can enhance the navigational accuracy of deep space missions.

An introduction to the *Pioneer* Venus Mission was given in Ref. 1. The Ames Research Center (ARC) plans to award two Phase B Study Contracts during July 1972. It is planned to complete this study within nine months.

On June 15, 1972, DSN/JPL representatives gave to the members of the ARC Study Teams a detailed presentation on advanced DSN capabilities, which will be implemented during the next three years. These new capabilities are the DSN Ranging System and S- and X-band dual-frequency system. These capabilities will be used by the approved *Mariner* Venus–Mercury 1973, *Helios*, and *Viking* Missions. The DSN team elaborated on the limitations of the DSN Tracking System used to precisely navigate spacecraft with predetermined target areas of planetary missions. To improve the required accuracies, the advantages of two-station tracking methods were explained using the Differenced Range method. It was emphasized that a spacecraft ranging capability provides faster trajectory solutions, reveals modeling errors, and makes it possible to use the differenced range versus integrated doppler (DRVID) solutions. This technique can be helpful to determine charged particle effects on tracking accuracies. Simultaneous data obtained from two or three stations and further quasi very long baseline interferometer (QVLBI) techniques can reduce considerably the errors of ephemeris uncertainties, but these techniques need charged particle calibrations using S/X-band capabilities. These capabilities can also lead to better calibration of conventional data, can complete the calibration of differenced data, and can be helpful in the close vicinity of the Sun. The advantages of the differential VLBI techniques using well-known locations of extra-galactic radio sources versus the position of a spacecraft can also enhance the navigational accuracies. References 1–14 describe these techniques in more detail. Information was also given on the spacecraft ground equipment configurations and implementation plans with special emphasis on the ranging and S/X-band capabilities.

References

1. Hamilton, T. W., and Trask, D. W., "DSN Inherent Accuracy Project," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. I, pp. 11–13. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1971.

2. Winn, F. B., and Leavitt, R. K., "Refractivity Influence on DSS Doppler Data," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. I, pp. 31–41. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1971.

3. MacDoran, P. F., Callahan, P. S., and Zygielbaum, A. I., "Probing the Solar Plasma With *Mariner* Radio Metric Data, Preliminary Results," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. I, pp. 14–21. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1971.

4. von Roos, O. H., "Second Order Charged Particle Effects on Electromagnetic Waves in the Interplanetary Medium," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. II, pp. 42–48. Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1971.

5. von Roos, O. H., "Analysis of the DRVID and Dual Frequency Tracking Methods in the Presence of a Time-Varying Interplanetary Plasma," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. III, pp. 71–76. Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1971.

6. Ondrasik, V. J., and Mottinger, N. A., "An Examination of the Effects of Station Longitude Errors on Doppler Plus Range and Doppler Only Orbit Determination Solutions With an Emphasis on a *Viking* Mission Trajectory," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. IV, pp. 71–77. Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1971.

7. Rourke, K. H., and Ondrasik, V. J., "Application of Differenced Tracking Data Types to the Zero Declination and Process Noise Problems," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. IV, pp. 49–60. Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1971.

8. Ondrasik, V. J., and Rourke, K. H., "An Analytical Study of the Advantages Which Differenced Tracking Data May Offer for Ameliorating the Effects of Unknown Spacecraft Accelerations," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. IV, pp. 61–70. Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1971.

9. Fanselow, J. L., et al., "The Goldstone Interferometer for Earth Physics," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. V, pp. 45–57. Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1971.

10. Fliegel, H. F., "A Worldwide Organization to Secure Earth-Related Parameters for Deep Space Missions," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. V, pp. 66–73. Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1971.

11. von Roos, O. H., "Analysis of Dual-Frequency Calibration for Spacecraft VLBI," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VI, pp. 46–56. Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1971.

References (contd)

12. Rourke, K. H., and Ondrasik, V. J., "Improved Navigation Capability Utilizing Two-Station Tracking Techniques for a Low-Declination Distant Spacecraft," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VII, pp. 51–60. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1972.

13. Thomas, J. B., "An Analysis of Long Baseline Radio Interferometry," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VII, pp. 37–50. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1972.

14. Thomas, J. B., "An Analysis of Long Baseline Radio Interferometry, Part II," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VIII, pp. 29–38. Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1972.