Pioneer Venus 1978 Mission Support

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The DSN Master Schedule for preparations for the Pioneer Venus 1978 Orbiter and Multiprobe Mission is described.

I. Introduction

Accompanying this article is the DSN Major Milestone Schedule (Figs. 1 and 2) for Pioneer Venus 1978 Orbiter and Multiprobe. What follows is a description of the DSN plans for preparing for Pioneer Venus 1978, including current status, using the attached schedule.

A Support Instrumentation Requirements Document (SIRD) for Pioneer Venus 1978 was received in October 1975 and is awaiting NASA Headquarters review and signature. A NASA Support Plan (NSP) will be prepared by the Tracking and Data Systems Manager for Pioneer Project three months after the receipt of a signed Support Instrumentation Requirements Document.

The major mission events for Pioneer Venus are the launch of the Orbiter in May 1978, followed by the launch of the Multiprobe Mission in August 1978. Both launches will utilize an Atlas-Centaur launch vehicle. The Orbiter will go into orbit around the planet Venus on about 1 December 1978, with the Multiprobe entry into the Venusian atmosphere about five days later. The release of the Probes from the Bus spacecraft will take place in late November 1978.

II. DSN-Spacecraft Compatibility Tests

Deep Space Network-Spacecraft compatibility testing will take place in three phases: weak signal level and strong signal level testing at the Compatibility Test Area (CTA 21) at JPL and compatibility testing at Cape Canaveral using the DSN equipment located at the STDN MIL Station. The weak signal level testing will take place in March 1977 and will utilize breadboard or flight spare spacecraft components which will be brought to CTA 21. It is not currently planned to bring a telemetry subsystem for these tests; however, the Project is planning to provide some means of generating realistic telemetry signals to play through the spacecraft radio system. The weak signal level testing will include X-band tests.

The strong signal level testing will take place in October 1977 for the Orbiter, and in January 1978 for the Multiprobe mission. Strong signal level testing will be accomplished using the actual spacecraft located at Hughes Aircraft Company, with signals relayed via microwave to CTA 21. X-band testing will not be required as it is anticipated the microwave will not support an X-band link.

III. Mission Operations System Readiness

The Project plans to establish Ground Data System compatibility by testing the Ground Data System in December 1977. For this purpose, the DSN will have at least one station in launch readiness by November 1977. The DSN will have achieved complete launch readiness (at least one 26-meter subnet) by 1 February 1978. The Ground Data System and Near-Earth Readiness dates are the same: 1 April for the Orbiter, and 1 July for the Multiprobe. The Launch Operational Readiness testing will be accomplished in early May for the Orbiter, and early August for the Multiprobe.

The Ground Data System and Mission Operations System encounter readiness date has not yet been established, nor has the DSN encounter readiness date been negotiated with the Project.

IV. DSN Multimission Implementation Required by Pioneer Venus

Pioneer Venus 1978 will be utilizing new-generation DSN Telemetry and Command Systems that involve replacing the existing XDS-920 computers with minicomputers which separate the telemetry and command functions. Included in this implementation is a minicomputer replacement for the Tracking System hardware at the Deep Space Stations. In addition, a minicomputer will be implemented to control the communications interface with the stations and will also provide a centralized digital Original Data Record. The Multimission schedule for the 920 computer replacement (whose official name is the DSN Mark III Data Subsystems Implementation Project) is shown on Lines 12 and 13 of the schedule (Fig. 1).

The telemetry and command software for Pioneer Venus 1978 will have a two-phase implementation. All of the command software and the telemetry software for interplanetary flight and orbital operations will be delivered in mid-September 1976. The remaining telemetry software for support of the Multiprobe entry will be delivered in mid-March 1977. The second delivery of telemetry software will provide the capability to support the multiple telemetry streams required during the Multiprobe entry as well as the special capability to record the soft decisions out of the Symbol Synchronizer Assembly for two telemetry streams at the Goldstone Mars Station (DSS 14) and the Australia Ballima Station (DSS 43). This latter capability is required because the Multiprobe entry will require the simultaneous reception at each station of four convolutionally coded telemetry streams, whereas the DSN is implementing the capability to decode only two streams in real time.

It is planned to complete the S-X conversion of one 26-meter Deep Space Station prior to the orbital operations of Pioneer Venus. This will require five months of downtime starting 1 July 1978, with full operational status reached by 1 December 1978. This implementation should help alleviate some of the conflicts for 64-meter station coverage during the simultaneous Pioneer Venus orbital operations and Mariner Jupiter–Saturn encounters of the planet Jupiter.

The DSN is converting to 7200-bit-per-second high-speed data blocks in December 1976, which also requires a change of communications equipment at the Ames Research Center's Pioneer Mission Operations Control Center.

Hydogen masers will be operational in the 64-meter subnet by 1 July 1977, and are required to support the Differential Long Baseline Interferometry (DLBI) Wind Measurement Experiment of the Multiprobe Mission.

V. Receiver Implementation

The remaining part of this article deals with implementation items specifically required for the Multiprobe portion of the Pioneer Venus 1978 mission (see Fig. 2). The first two items listed are additional receivers which are required to support the multiple signals which will be present for the Multiprobe entry. An earlier Progress Report article (Ref. 1) should be consulted for a description of the receiver configuration and analog recording requirements for the Multiprobe entry. Briefly, four Probes will be simultaneously entering the Venusian atmosphere, and the DSN will be required to simultaneously acquire four signals which have not been seen since the spacecraft was launched. An attempt will be made to acquire and maintain in two-way coherent lock one of the four Probes during the Probe entry. Five closed-loop receivers are therefore required to support the Multiprobe entry, which is one more than the usual complement of receivers at a 64-meter station. The fifth receiver is required because an attempt will be made to maintain the large Probe in two-way coherent lock, which could be one-way at any given time during the entry. As a means of recovering data during the time period when the closed-loop receivers have not acquired lock, a pre-carrier detection telemetry recording system is being implemented for Pioneer Venus. This requires four open-loop receivers, one per Probe, which is two additional open-loop receivers compared to the usual 64-meter configura-

tion. These six additional receivers (one closed-loop and two open-loop at both DSS 14 and DSS 43) are being produced by modifying surplus Manned Space Flight Network Block III equivalent receivers. These receivers are to be manufactured by 1 September 1977 and operational by 1 January 1978.

VI. Predetection Telemetry Recording

The pre-carrier detection telemetry recording to be implemented for Pioneer Venus is also described in Ref. 1. It involves procurement of a new generation of analog recorders to record the output of open-loop receivers with the data from each Probe going on to a separate track of the recorder. These recordings will then be played back through an up-converter into the closed-loop receivers at CTA 21. The necessary up-converters will also be provided to DSSs 14 and 43, but only for the purpose of pre- and post-track validation that the predetection recording equipment is operating properly. A prototype of this recording system is undergoing evaluation which should be completed by 1 July 1976. The operational recorders will be installed at CTA 21 on 1 January 1977, at DSS 14 on 1 June 1977, and at DSS 43 in mid-September 1977.

VII. Differential Long Baseline Interferometry Wind Measurement

The Differential Long Baseline Interferometry Wind Measurement Experiment for the purpose of measuring the wind velocities in the atmosphere of Venus was described in great detail in Ref. 2. A preliminary plan has been developed for validating the Network's capability of meeting the requirements of this experiment and for developing the necessary calibration and receiver interfaces. This preliminary plan is shown on lines 7 and 8 of Fig. 2. The plan is to develop a preliminary block diagram for the calibrator and receiver interface for the experiment by 1 May 1976, and to have completed the prototype design by 1 July 1976. The prototype should be completed by 1 September 1976. Concurrent with the design and prototype development will be testing in order to determine the Network performance (principally in the area of relative phase stability across the required bandwidth) starting in about June 1976, with a full evaluation of the prototype equipment starting at the completion of the construction of the equipment in September 1976. It is tentatively planned to install the prototype equipment at DSS 14 after the end of the primary Viking Mission in December 1976 and to complete its evaluation by 1 February 1977. The final design of the operational system, based on the experience with the prototype, will start in late-1976 with completion of the operational design by 1 February 1977. Fabrication of the equipment will be completed by 1 September 1977 to achieve an operational capability in the DSN stations by 1 January 1978. The Space Flight Tracking and Data Network (STDN) will be required to develop the receiver interface and calibration system for the STDN stations which will support the Multiprobe entry (Santiago, Chile and Guam). The detailed schedule of the STDN activity and how it will interface with the DSN activity has not yet been negotiated.

The high-rate digital recorders required for the DLBI experiment will undergo testing of the prototype units during 1976, with a target to complete evaluation of the prototypes by 1 October 1976. The DSN is responsible for interfacing the recorder subsystem with the STDN timing and power equipment; the design of these required interfaces is in process with completion targeted for 1 July 1976. Procurement of the operational recorders will start in July 1976, with the completion of manufacture of the recorders targeted for April 1977. The associated monitor and control electronics will be completed by 1 April 1977, with integration to follow with completion in July 1977. It is then planned to have a trial installation for integration test purposes at the STDN station located at Goldstone, California, during August 1977. The original plan was for this integration testing at the STDN station to take place in November 1977, but the date has been moved up to be compatible with the desired operational date at the overseas stations. It is planned to have the Mars station (DSS 14) and the Santiago STDN station operational for the DLBI experiment in January 1978, with DSS 43 and Guam operational in February 1978. The experimenter's schedule for providing the interface at the Massachusetts Institute of Technology for utilizing the high-rate digital recordings produced at the stations has not yet been negotiated, but the Massachusetts Institute of Technology must be capable of receiving tapes to process them for validation purposes by January 1978. Completion of the station's implementation for the DLBI experiment in January and February 1978 will allow ten months of evaluation and testing and training prior to the Multiprobe entry.

VIII. Multiprobe Entry Simulation and Signal Presence Indicator

Two remaining implementations are planned to support the Multiprobe entry of Pioneer Venus. First is a means of dynamically simulating the signals of the four Probes, both realistically in signal level and doppler. This implementation is felt to be necessary since the DSN will not simultaneously see the four Probe signals until the actual entry event.

The final implementation will be signal presence indicator for DSSs 14 and 43 to be used in real time during the Multiprobe entry. This device will be some type of fast Fourier transform device which will enable taking a spectrum out of the open-loop receiver to determine that all signals are present.

References

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, California, June 15, 1975.
2. Miller, R. B., "Pioneer Venus 1978 Mission Support," in *The Deep Space Network Progress Report 42-31*, pp. 11–14, Jet Propulsion Laboratory, Pasadena, California, Feb. 15, 1976.

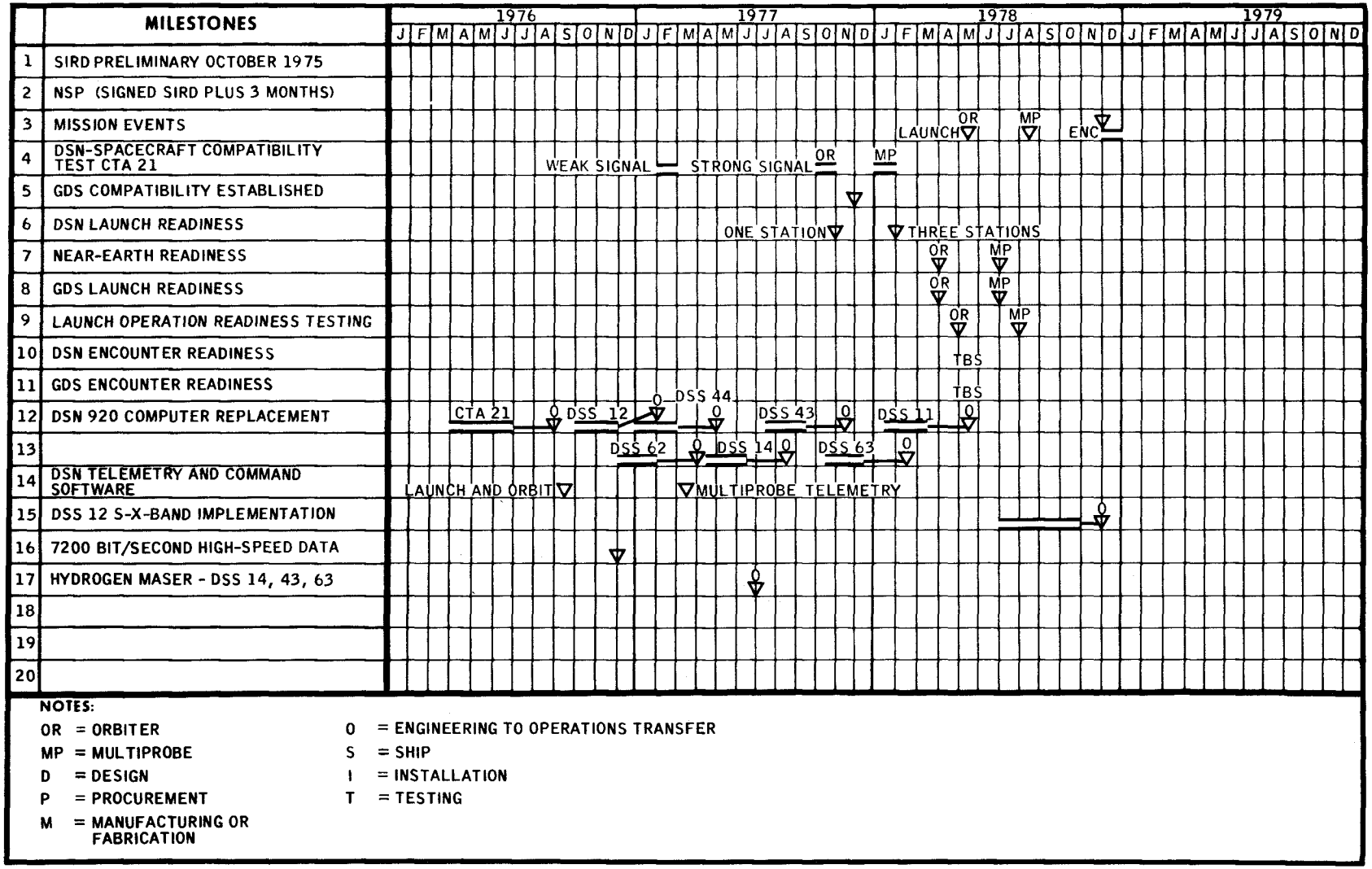

Fig. 1. DSN major milestone schedule for Pioneer Venus 1978 Orbiter and Multiprobe

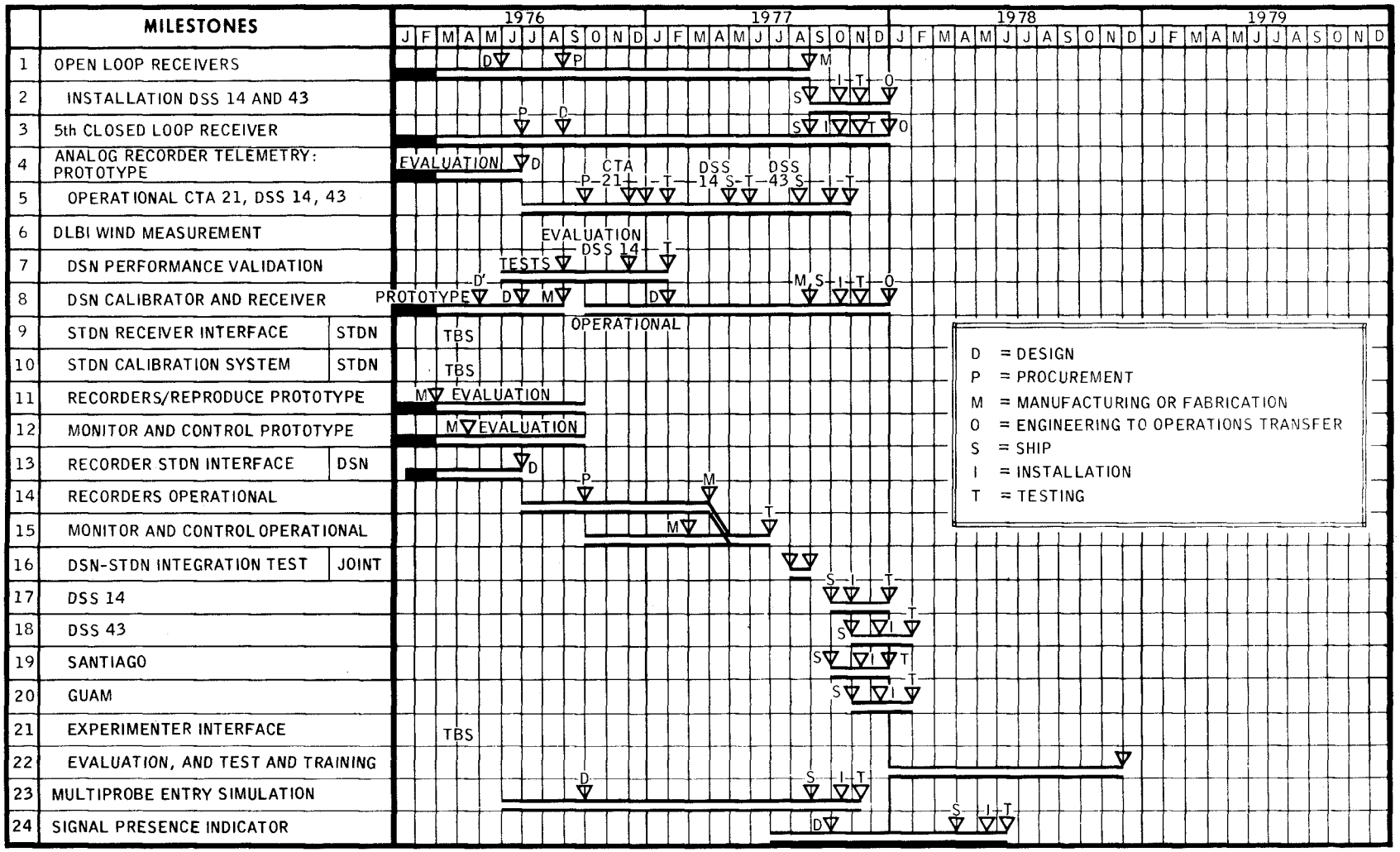

Fig. 2. DSN major milestone schedule for Pioneer Venus 1978 Multiprobe