Mariner Venus/Mercury 1973 Mission Support

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Following the successful launch on November 3, 1973, DSN emphasis for Mariner Venus/Mercury (MVM'73) switched from premission preparations to flight support. However, a high level of implementation activity continued in parallel to achieve operational readiness of additional capabilities committed to be available by January 1, 1974.

I. Planning Activities

A. NASA Support Plan (NSP)

NASA Headquarters acted quickly on the NSP, which was revised and resubmitted for approval on October 25, 1973. Approval was completed on October 31, 1973, and the DSN published and distributed Revision 1 immediately thereafter. This will be the final issue for the MVM'73 primary mission, which extends to April 15, 1974. Support commitments for extended mission operations, if approved, will be documented in a new NSP scheduled for publication in April 1974.

B. DSN Operations Planning

During November and December 1973, emphasis was on proper execution of the previously published DSN Operations Plan for MVM'73. However, to accomplish this in the heavy support load environment, daily planning sessions with the Project were required to produce workable, detailed schedules and sequences of events. The Pioneer/Mariner 10 64-m subnet sharing plan described in the previous article was made more complex by the occurrence of Mariner 10 spacecraft problems resulting in numerous real-time changes to DSN schedules, sequences, and procedures.

II. Program Control

A. Status Reviews and Reports

Weekly status meetings with the Project continued throughout this reporting period. Subsequent to the successful completion of launch and near-Earth television operations, additional items pertinent to Mariner 10 cruise and encounter operations were added to the "Critical Lien List:" DSSs 43 and 63 planetary ranging, DSS 14 S/X-band, DSSs 43 and 63 high-rate video telemetry data handling, open-loop receiver/occultation recorder verification, 10 sample/s doppler capability, and recall capability for DSS radio metric original data records (ODRs). The DSN has issued daily and weekly status reports to a

wide distribution during the critical and cruise phases respectively. Submission of monthly inputs to the Project Management Report continues.

III. Implementation Activities

Following the very successful support given to Mariner 10 in the early part of November 1973, the DSN gave full attention to the resolution of problem areas and to open implementation required to be completed by January 1, 1974. A summary of these items is given in Table 1.

1. Telemetry and command data subsystem (TCD). Previously reported problems regarding telemetry original data recording quality were resolved prior to launch except for time tag errors. A hardware solution for random occurrences of large timing errors in the timing distribution system/Telemetry and Command Processor (TCP) clock was not possible for MVM'73; therefore, operational procedures were designed to reduce or eliminate effects on data records. The Network Operations/Analysis Team checks timing accuracy of real-time telemetry blocks during each DSS prepass countdown. If timing errors are observed, front panel restarts are accomplished on TCD subsystem assemblies to reset the clock to the correct time. Checks are continued hourly during DSS tracks and the procedure is repeated as necessary.

The third Data Decoder Assembly required to complete the DSSs 61 and 63 conjoint DSS three-string configuration was installed and checked out. Three strings are required at the conjoint 26- and 64-m DSS to accommodate (1) real-time recording of 117 kilobits/s video, (2) real-time handling of 2450 bits/s nonimaging science, and (3) near-real-time, reduced-rate playback of video data via 28.5 kilobits/s wideband communications circuits.

Digital recording of radio metric data in the DSS digital instrumentation subsystem (DIS) was initiated during the MVM'73 preparation period. However, the capability for posttrack recall/replay of these data was not developed in parallel. To achieve this capability in a timely manner, an overlay modification for an existing telemetry replay software program is being prepared for delivery in January 1974. This will involve replay of DIS recorder-produced digital tapes via the TCP/recorder requiring DIS/TCP tape deck compatibility. In the interim, radio metric data may be recalled via low-speed punch recorder replay.

2. Tracking data handling subsystem (TDH). Implementation of planetary ranging capabilities continued at DSSs 43 and 63 during this period; however, there was little productive time due to Pioneer 10 encounter configuration freezes. In addition, installation kits were not complete in that a few required cables were not available. Consequently, the January 1, 1974 readiness date was not met. The impact of this late implementation on Project navigation was, at first, not significant since the DSN Mark IA Lunar Ranging Assembly was still providing good ranging data from 26-m DSSs. Mark IA support could have continued through late January 1974; however, on December 25, 1973, the spacecraft high-gain antenna experienced a problem that resulted in a significant loss in downlink signal performance. Since ranging from 26-m DSSs was no longer possible, priority action was taken to assure completion of planetary ranging checkout by January 15, 1974.

3. Digital instrumentation subsystem (DIS). Although the TDH subsystem was modified earlier to generate doppler data at a rate of 10 samples/s, the existing DIS software program could not handle this rate. This capability is required for radio science experiment support at planetary encounters, particularly at Mercury. Final checkout of the necessary software program update is in process and is scheduled for release in January 1974.

4. Antenna microwave subsystem. Analysis of DSS 14 low-noise ultracone performance indicated that this capability would most likely permit sufficient RF link performance to support a video data rate of 117 kilobits/s at Mercury encounter. This would significantly increase the science return from Mercury since rather high-resolution coverage of the entire lighted disk would be possible. Consequently, the decision was made to install an ultracone at DSS 43 to provide 117 kilobits/s coverage of the Mercury out-going TV sequence. The cone has been shipped to Australia, and installation is planned in mid-January 1974.

5. S/X-band equipment. As reported in Ref. 1, installation of the R&D S/X-band equipment, except the Command Modulator Assembly switch, was completed at DSS 14 in late October 1973. However, completion of checkout and an operable status was not achieved by January 1, 1974, as planned due to a number of problems. First, S/X-band checkout during November–December 1973 at DSS 14 was very difficult and at times impossible due to conflicts with the load, configuration control, and freeze imposed at the station for Pioneer 10 encounter. Secondly, subsystem interface cable noise problems and faulty assembly modules further delayed achievement of

valid data. Most problems exhibited themselves in the X-band rather than S-band data in the form of frequent doppler cycle slips and offsets. Increased use of DSS 14 by Mariner 10 in January 1974 should improve this situation in preparation for Venus encounter.

IV. Operations Summary

Final DSN operational readiness tests were satisfactorily completed during the last week of October 1973, in preparation for Mariner 10 launch and near-Earth TV operations. Mariner 10 was launched on November 3, 1973 as planned, and the DSN has provided continuous coverage to date via a combination of 26-m and 64-m subnet deep space stations: DSSs 12, 42, 62, 14, 43, and 63. During November and December 1973, most coverage was provided by the 26-m subnet, with DSS 14 averaging about three passes per week. DSSs 43 and 63 tracks of Mariner 10 were nil due to higher priority support for Pioneer 10. DSS 44 was brought into use for Mariner 10 on a rush basis to avoid a 4-h gap in coverage on December 3, 1973 due to Pioneer 10's use of both DSSs 42 and 43 during encounter closest approach.

DSN support for Mariner 10, including the high-activity Earth–Moon TV sequence and trajectory correction maneuver, has to date been excellent. As expected in a continuous coverage operation, the DSN has experienced problems and equipment failures; however, none has had a significant impact on mission operations and data recovery.

Reference

1. Davis, E. K., "Mariner Venus-Mercury 1973 Mission Support," in *The Deep Space Network Progress Report*, Vol. XVIII, pp. 5–15. Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1973.

Table 1. Postlaunch implementation and problems

Open implementation (I) and problems (P)		Location
Block IV S/X-band ranging/ doppler	(I)	DSS 14
Planetary ranging	(I)	DSSs 43 and 63
10 Sample/s doppler	(I)	All DSSs
Radio metric original data record replay	(I)	All DSSs
Open-loop analog recording	(I/P)	DSSs 14 and 43
Standard analog recording validation and improvement	(P)	All DSSs
Low-noise ultracone	(I)	DSS 43
Third Data Decoder Assembly	(I)	DSS 61/63
Digital telemetry ODR time tag error	(P)	All DSSs
Command Modulator Assembly (CMA) switch	(I)	DSS 14