Helios Mission Support

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Project Helios is a joint deep space project of the Federal Republic of West Germany and the United States. Two solar orbiting spacecraft are planned, the first to be launched in mid-1974 and the second in late 1975. The spacecraft will have a perihelion of approximately 0.25 AU and an aphelion of 1.0 AU. These highly elliptical orbits will come closer to the sun than any known or presently planned deep space venture.

Prior volumes of this series describe the history and organization of this program, the spacecraft configuration and trajectory, its telecommunications system, and the results of the semi-annual Helios Joint Working Group Meetings, which are held alternately in the United States and the Federal Republic of West Germany. This article deals with DSN activities since the Sixth Helios Joint Working Group Meeting, which was held at JPL in April–May 1972.

I. Introduction

Volume X (Ref. 1) of this report described the Tracking and Data System (TDS) activities and highlights of the Sixth Helios Joint Working Group (HJWG) Meeting, whose proceedings are recorded in its formal minutes (Ref. 2). This article summarizes the DSN activities since that date, including the DSN preparations for the Seventh HJWG Meeting, which will be held in Porz-Wahn (near Bonn), West Germany, October 25–31, 1972.

II. DSN/Helios Trainee Program

It is most appropriate to open this article with a discussion of the DSN/Helios Trainee Program (Ref. 3,

p. 19) since it has now come to a formal conclusion. In the 3-year period from September 1969 to September 1972, fifteen West German engineers spent 1 year at their government's expense in residency at the Jet Propulsion Laboratory to further their knowledge of space flight technology in their own particular fields by being assigned duties on JPL programs that employed techniques and skills needed by the Helios Project.

Now that the Trainee Program has concluded, it is proper to reflect upon its value. First, not enough can be said about the excellent caliber—both technical and personal—of those who participated in the program. Each Trainee was a credit to his country, his organization, and certainly to the Helios Project Management that selected

him for this purpose. Secondly, the program can be considered highly successful, despite the fact that it was not always possible to achieve 100% correlation between the Trainees' future Helios responsibilities and on-going JPL activities. Fortunately, this correlation was very high in a majority of the cases, and more than satisfactory in the remaining instances. The success of the Program has already been demonstrated by the Trainees who have returned to Germany and have contributed heavily to the Helios Project efforts, in both a technical and managerial capacity. Third, the intangible asset of "team spirit" that prevails throughout the Helios Project is due, in part, to the Trainee Programs instituted by the Project at such NASA facilities as the Goddard Space Flight Center and the Jet Propulsion Laboratory.

III. DSN Configuration for Helios Support

The expanding NASA-TDS effort in support of Project Helios is the result of two independent but overlapping factors. The first is the logical redefinition of responsibilities between NASA's Offices of Space Sciences (OSS) and Tracking and Data Acquisition (OTDA) which has evolved over the past year's time. The second factor is that Helios is now only slightly over 1½ years from launch, which means that the various line organization teams are building in preparation for launch and mission operations. The combination of these two factors has resulted in a slightly modified NASA-TDS structure from that originally depicted in Ref. 3 (Fig. 1, p. 20).

A. DSN Configuration for Helios

The presently planned DSN configuration for Helios, shown in Fig. 1, depicts a data flow pattern that is markedly similar to that described in Ref. 3. The significant difference lies in the DSN–Mission Control and Computing Center (MCCC)[1] interface. Prior to the redefinition of the OSS/OTDA division of responsibility, the MCCC was part of the DSN and hence funded by OTDA. Under the new organizational structure, the MCCC is funded by OSS in order to provide single Headquarters Office control over both the mission-independent and the mission-dependent Mission Control Center hardware/software activities. This, therefore, places the DSN interface as depicted in the upper right-hand corner of Fig. 1.

B. Interim Network Control System

The new DSN interface with the Flight Project Ground Data System is further depicted in Fig. 2. The significant

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[1]Formerly called Space Flight Operations Facility (SFOF).

change shown in this figure is that all spacecraft-oriented data flow directly to/from the Deep Space Stations and the Mission Control and Computing Center (which houses the Flight Project activities) or, in the case of a Remote Mission Operations Center, the MCCC acts as the collecting/processing/distributing point for all spacecraft-oriented data. However, the DSN is still responsible for the Network Control function. To accomplish this, the Network Control System (NCS) is placed "off-line" to the flow of spacecraft data, but has access to it to the extent needed to perform network functions. The implementation of a Network Control System represents a new DSN activity, which has a planned but staggered operational readiness schedule that will be completed very close to the Helios-A launch date. Therefore, to accommodate Helios pre-mission testing and training as well as avoid confusion during Helios-A launch, an interim NCS configuration will become operational about 6 months prior to the first Helios launch and will contain the functions depicted in Fig. 2.

IV. Significant Events Since the Sixth Helios Joint Working Group Meeting

A. NSP and Other Interface Documentation

1. NASA Support Plan (NSP). A preliminary NSP, dated September 1, 1972, was issued in response to the Deep Space Phase requirements set forth in the preliminary Helios Support Instrumentation Requirements Document (SIRD), dated September 1, 1971. This issue of the NSP treats the interface and the support requirements between the Helios spacecraft and the DSN, together with the spacecraft data that the DSN will deliver/receive via the DSN/MCCC interface to the Helios Ground Data System. Per NASA-OSS/OTDA agreement, the response to the Helios SIRD requirements for ground data processing will be contained in a new document titled "MCCC Support Plan (MSP)," which will be prepared by that organization. Progress regarding the MSP will be reported separately.

2. SIRD. Pre-signature copies of the final Helios SIRD were received by the DSN in mid-September 1972. This document is presently undergoing review prior to starting preparations for the final NSP, which is due April 1, 1973.

3. Helios spacecraft/DSN interface. The Helios Spacecraft Telecommunications Subsystem/DSN Interface Definition Document (JPL Document 613-6) is authored jointly by the DSN Manager for Helios and the Helios

Spacecraft Systems Manager, each contributing his portion of the interface definition. At the present time, the DSN portion of the manuscript has received formal approval, and the document is now undergoing German author review and approval. Publication is anticipated prior to the end of the year.

4. Helios telecommunications link design. By mutual Helios Project/DSN agreement, the Helios Telecommunications Link Design and Performance Analysis Document will be maintained and controlled by the Project Office, but shall be constrained by the DSN performance parameters contained in the Interface Definition Document (613-6) mentioned above. The Link Design Document was originally issued on June 30, 1971, but has subsequently been updated—the latest update being in September 1972. It is anticipated that further updates may become necessary as the actual performance of the Prototype and Flight Model Spacecraft Telecommunications Subsystems becomes known.

B. DSN Planetary Ranging System Design

In response to an urgent Sixth HJWG action item, the DSN Management has made a decision to implement, for the Helios era, a 64-m-diameter antenna station planetary ranging system design that will be capable of using either a "continuous spectrum" (Tau) or a "discrete spectrum" (Mu) ranging code. This decision will permit the Helios Project to employ whichever ranging code best fulfills the mission objectives at the specific times the spacecraft is being supported by a DSN 64-m station. A planetary ranging system capability is not being planned for the DSN 26-m stations; however, the latter will retain the Mark I-A lunar continuous spectrum ranging capability, which can provide unambiguous range data to a distance of 800,000 km.

C. Status of Compatibility Test Effort

As mentioned in Ref. 1 (p. 15), compatibility tests were performed on the Helios Engineering Model (EM) Spacecraft Radio Subsystem (JPL Documents 613-5 and 613-8) during April 1972. While these tests can be considered satisfactory, two significant factors should be noted: first, the receiver employed in the tests has subsequently been replaced by a new design and second, the tests did not incorporate the spacecraft data handling portion of the equipment.

With respect to the first factor, a meeting held in July 1972 in Bonn, West Germany, between the TDS Manager and the Helios Spacecraft Telecommunications Subsystem Manager concluded that certain of the Engineering Model Telecommunications Subsystem compatibility tests should be repeated for technical reasons. However, the Engineering Model spacecraft schedule was such that it was prohibitive to consider returning the Spacecraft Radio System to Deep Space Station (DSS) 71/Compatibility Test Area (CTA) 21 for this purpose. Instead, it was decided to repeat the tests using the Project-supplied Helios Test Set (HTS) while the EM spacecraft was still at the prime contractor's plant at Ottobrun, West Germany. These repeated compatibility tests are presently scheduled for later this year. While it is recognized that the HTS is not an exact technical substitute for a Deep Space Station, the test results (613-8) obtained from the EM transponder tests at DSS 71 did correlate reasonably well with similar tests performed on the EM transponder using the HTS equipment in Germany prior to its shipment to DSS 71. The technical importance of repeating these tests, therefore, outweighed the disadvantage of not being able to repeat them at a Deep Space Station.

The other factor, namely that no tests have yet been conducted regarding the Data System compatibility, is still considered significant because the next scheduled opportunity is not until the arrival in the U.S. of the Prototype Model in early 1974. Unfortunately, in this case, work-around techniques are not quite so obvious. One consideration is the possible use of spacecraft test tapes obtained by the HTS for checkout against the Ground Data System. However, for both technical and practical reasons, such test tapes have their maximum usefulness during the 6-month time period preceding the arrival of the Prototype Model for compatibility tests. Therefore, other possible techniques are being explored that might be employed at an earlier date in order to gain confidence in the total spacecraft/Ground Data System design.

V. DSN Preparations for the Seventh Helios Joint Working Group Meeting

The DSN is represented in the Helios Joint Working Group structure via membership on the TDS Subgroup Panel (see Fig. 1, p. 20, of Ref. 3). The total TDS agenda for the Seventh HJWG is quite extensive because it involves the activities of the Near-Earth Phase Network, the Deep Space Network, and the German Network, plus all of the ground data handling equipment in both the U.S. and in Germany that is necessary for real-time operations, as well as the production of the final Experiment Data Records (EDR). Within this ex-

tensive agenda, the DSN is particularly interested and expects to participate heavily in discussions regarding

(1) The mutual compatibility of the overall telecommunications design with respect to the DSN.

(2) The resolution of specific open questions, such as the use of coded vs. uncoded spacecraft telemetry during launch, the problem of DSN blind acquisition of the spacecraft in the event of loss of downlink, etc.

(3) The detailed definition of the mission-independent interface between the DSN and the German Network in support of Helios.

The foregoing, plus related topics, are expected to undergo extensive discussion during the Seventh HJWG proceedings. In fact, because of the overcrowded nature of the formal TDS agenda, it may become necessary to treat some of these topics in special splinter sessions scheduled outside the formal Working Group proceed-

ings. In the interest of making these technical sessions as productive as possible, the DSN has organized special pre-meeting study teams on the above key agenda topics to analyze in depth the possible technical alternatives so that the Working Group sessions will have the benefit of the maximum available knowledge prior to making a decision on the best course of action for Helios to pursue. In this manner, it is hoped that the Seventh HJWG will prove to be highly productive for all participants.

VI. Conclusions

This article has provided a synopsis of the significant DSN activities since the Sixth Helios Joint Working Group Meeting. It is anticipated that the next article will report upon the findings and conclusions reached during the Seventh HJWG meeting, scheduled for October 25–31, 1972, at the Deutsche Forschungs und Versuchsanstalt für Luft- und Raumfahrt (DFVLR) facility at Porz-Wahn (near Bonn), West Germany.

References

1. Goodwin, P. S., "Helios Mission Support" in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. X, pp. 14–19, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1972.

2. *Project Helios Minutes of the Sixth Helios Joint Working Group Meeting at Jet Propulsion Laboratory, Pasadena, California, April 26–May 3, 1972*, Goddard Space Flight Center, Greenbelt, Md.

3. Goodwin, P. S., "Helios Mission Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. II, pp. 18–27, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1971.

△1 1 VOICE, 2 TTY, 1 HSDL TO EACH DSS

△2 DSS VOICE CIRCUITS CONFERENCED AT DSC 10 AND GSFC SWITCHING CENTERS
DURING NONCRITICAL PERIODS

△3 CIRCUIT BETWEEN MADRID SWITCHING CENTER AND GERMAN CONTROL CENTER
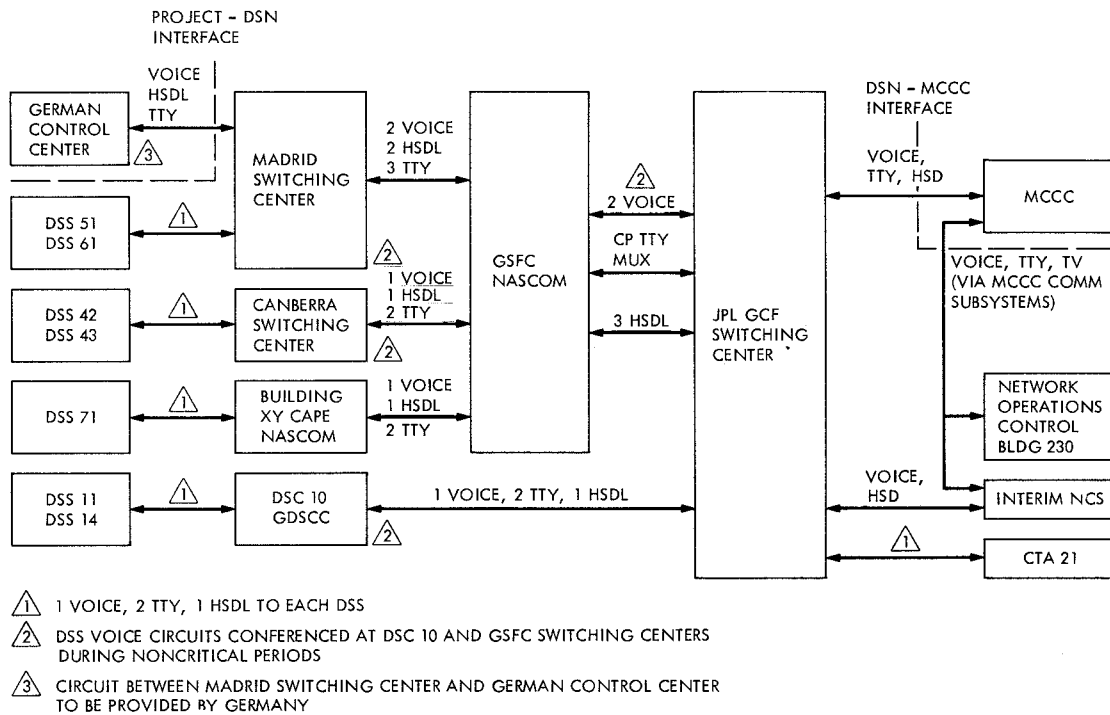TO BE PROVIDED BY GERMANY
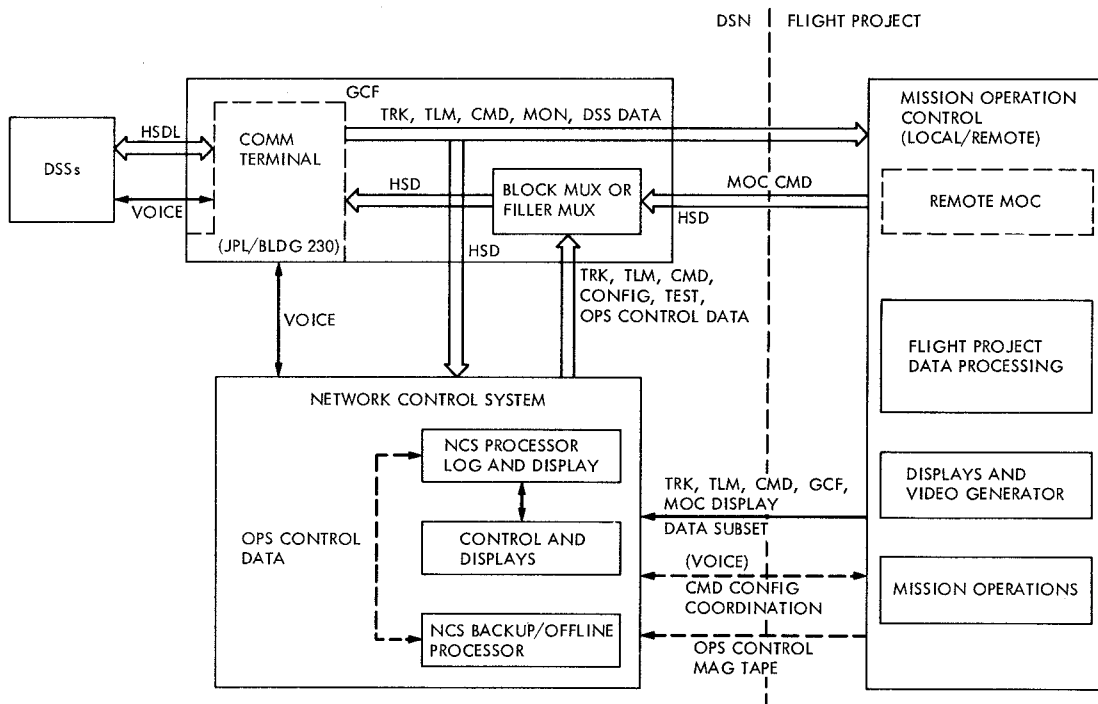
Fig. 1. Network configuration and ground communications plan for Helios

Fig. 2. Interim NCS/Facility/MOC interface