Pioneer Mission Support

A. J. Siegmeth
Mission Support Office

This report reviews the status of the second-generation Pioneer missions, Pioneers 6, 7, 8, and 9; and the prelaunch and launch support of Pioneer 10, which is the first member of the third generation, whose destinations are Jupiter and beyond. This mission was identified in previous reports as Pioneer F; it was renamed Pioneer 10 after its successful launch. The planning activities for the second mission of the third generation, Pioneer G, and a summary on the fourth-generation Pioneers planned for the exploration of Venus are also presented.

I. Pioneers 6, 7, 8, and 9

The second-generation *Pioneer* missions are still active. They are the first groups of interplanetary *Pioneers* managed and operated by Ames Research Center (ARC). The tracking and data acquisition support for these *Pioneers* has been furnished by the Deep Space Network since *Pioneer* 6 launch in December, 1965.

The second-generation *Pioneers* are actively orbiting the Sun and continue to return data on fields and particles of the solar wind and plasma particles originating from the Sun and the galaxy. In addition, they map the magnetic field of outer space.

The accomplishments of *Pioneers* 6 through 9 can be summarized as follows:

(1) The precise determination of the characteristics of the solar atmosphere called the heliosphere.

(2) Determination of solar cosmic ray and solar wind flow patterns and the magnetic and electric field mechanisms of the heliosphere.

(3) The longest-lived operational interplanetary spacecraft were: *Pioneer 6*, launched in December 1965; *Pioneer 7* in August 1966; *Pioneer 8* in December 1967; and *Pioneer* 9 in November 1968.

(4) By the end of April 1972 they will have achieved 245 months of operational life during their solar orbits. The Deep Space Network has collected, during this time, almost 20 billion bits of scientific and engineering data, which were processed by Ames Research Center, and analyzed and reported to the scientific community by the principal scientific investigators. A total of 26,300 commands have been transmitted to these spacecraft.

(5) These missions used for the first time the signatures of the telecommunications link for the determination of spacecraft spin axis orientation.

(6) *Pioneers* were first in gathering space weather data for operational use.

(7) *Pioneer 9* was the first spacecraft which used convolutional coding and sequential decoding resulting in a telemetry signal-to-noise improvement of almost 4 dB.

(8) *Pioneer 6* and *9* signals had occultations by the solar corona and disk, making possible the measurement of the Faraday rotation as the spacecraft's signal traversed the solar corona. In addition, the spectrum-widening effects of the S-band coherent signal were established.

(9) *Pioneer 7* was the first interplanetary spacecraft having a lunar occultation.

(10) The *Pioneer 6* and *7* signals were received by the Goldstone DSCC 64-m-diam antenna station simultaneously as the two spacecraft were flying within the beam of the single ground antenna.

(11) *Pioneers 6* and *7* were the first missions which established the radial and spiral characteristics of the solar wind and solar cosmic rays.

(12) *Pioneers 6* and *7* were the first interplanetary spacecraft which defined the characteristics of the Earth's magnetic tail.

(13) *Pioneers 6* and *9* were the first spacecraft having the capability of a telecommunications range adaptive telemetry system.

During the past year the DSN provided tracking and data acquisition support on a "time available basis" and within the Deep Space Station resource levels set for *Pioneers 10* and *G* and *Mariner 9*.

The actual number of support passes provided for the second-generation *Pioneers* during the past fifteen months is given in Figs. 1, 2, 3, and 4. The telemetry bit rates are also shown.

DSN is still using the *Pioneer* Ground Operations Equipment (GOE) at DSSs 12 and 14 in the Goldstone DSCC, and DSS 51 at Johannesburg, South Africa. This equipment is used to demodulate *Pioneer* telemetry and generate commands. Since DSN's policy is not to use mission-peculiar equipment and support all missions in the standard DSN Mark III system configuration, plans are under way to implement compatible software for *Pioneers 6* through *9* for the DSS Telemetry and Command Processing Systems software and the Space Flight Operations Facility compatible with the second-generation *Pioneers* and use a configuration similar to the one used for *Pioneer 10*. After these software modifications, DSN plans to retire the *Pioneer* GOE.

II. *Pioneer 10*

During the functional design phase of the *Pioneer 10* and *G* missions in 1968 and 1969, DSN intensively supported all *Pioneer* Project sponsored activities to assure that the spacecraft design was fully compatible with the DSN Mark III system and that every effort was made to obtain a near-optimum type data return.

The results of numerous preliminary design and interface agreements were compiled and published in a document entitled *Tracking and Data System Estimated Capabilities for the Pioneer F and G Missions*. The first edition of this publication was distributed on July 15, 1968, and three revisions followed on March 15, 1969, June 15, 1969, Dec. 15, 1969.

Figures 5 and 6 display the methodology which was applied to coordinate the *Pioneer* planning and implementation activities in the Laboratory's budgetary system. Only validated Project requirements were included in DSN's implementation plans compatible with the framework of the NASA budget.

The formal DSN planning started with the formation of a DSN Capabilities Planning Team (CPT). This team had the following membership:

Chairman: DSN Manager, *Pioneer* Project

Members: DSN Project Engineer, DSN System Engineers in charge of the development of the functional capabilities of the Mark III system, *Pioneer* Project representative, recording secretary

The CPT held twelve scheduled meetings between December 1969 and May 1970.

The purpose of this activity was to establish an overall network capability as required by the *Pioneer* Project and constrained by DSN resources. The CPT has also validated the Project's Support Instrumentation Requirements, which were included in the *Pioneer F & G Support Instrumentation Requirements Document* (SIRD). Prior to *Pioneer 10* launch the Project published five versions of the SIRD in June, July, and September 1970, and February and September 1971.

The CPT activities resulted in a preliminary document entitled: *DSN Operations Plan for Pioneers F and G*, *Vol. III, DSN System Description.* The summarized contents of this document were published in Refs. 1 and 2.

During the first quarter of CY'70, a new central processing system was installed at the SFOF for use by MM'71 and the *Pioneer F* and *G* Projects. This system consisted of two IBM 360/75 and two Univac 1108 computers. These machines have replaced the 7044 and 7094 configurations used in the past.

The DSN also started the planning of an interface between the Remote Information Center at Ames Research Center and the Space Flight Operations Facility (SFOF) at JPL. The objective was to give the *Pioneer* Project the capability to interface directly with the SFOF computers via a high-speed data line from Ames Research Center.

As a part of the Multiple Mission Telemetry System, DSN started the planning for the implementation of a sequential decoding capability at the Deep Space Stations. The Ground Communications Facility (GCF) also started the upgrading of the high-speed data line systems to 4800 bps.

In March 1970, the DSN also started the functional design and the implementation of a microwave link between the *Pioneer* spacecraft contractor, TRW, and the Compatibility Test Area (CTA 21) at JPL. This link installed later was used for the *Pioneer* Spacecraft/DSN RF and Data System Interface Compatibility Tests.

At the same time, a new multimission operations organization has been established by DSN. The intent was to organize network operations so that:

(1) Network integrity will be maintained.

(2) The Network can support many flights simultaneously.

(3) A multimission support capability with a more integrated network operation than has been feasible in the past would be possible.

Around May 1970, DSN made the decision to use DSS 11 at Goldstone DSCC, DSS 42 in Tidbinbilla, Australia, and DSS 61 in Madrid, Spain, as the tracking stations for *Pioneers 10* and *G*. NASA planned at that time to make these stations compatible not only with the unmanned planetary and interplanetary missions, but also with the manned missions, such as *Apollo*. Therefore, it was necessary to make these stations compatible with the DSN Mark III-type configuration and also with the Space Tracking and Data Network (STDN). The Telecommunications Division of JPL was tasked with the implementation of the described combined capability.

In December 1970, DSN started the *Pioneer 10* and *G* compatible design and development of the new real-time Central Processing System of the SFOF. This software system was developed in several phases. The first four models were designed for MM'71, and Models 5 and 6 for *Pioneers 10* and *G*. Each model contained the capabilities of its predecessor with additional capabilities as required by the corresponding flight projects. The construction of a new building designed to support the *Pioneer* Mission Support Area was also in progress.

In the same time period, DSN also established a conical scanning (Conscan) project which performed tests to evaluate the capability of the deep space stations to support the spacecraft Conscan system.

A letter of agreement (ARC/PPO-9) between the *Pioneer* Project and the Tracking and Data System management was endorsed. This agreement described all interfacing procedures necessary during the planning, test and flight phases of the *Pioneers 10* and *G* missions.

DSS 12 at Goldstone DSCC, DSS 41 at Woomera, Australia, and DSS 62 at Madrid, Spain, were named as backup stations to DSSs 11, 42, and 61. Detailed implementation schedules for the backup stations were generated.

Based upon trajectory data received from the *Pioneer* Project, DSN has made an initial acquisition study which has shown that neither DSS 42 nor DSS 61 could be used as a backup for the initial acquisition station, DSS 51. As a result, the Project has requested that the STDN station at Ascension Island be equipped with *Pioneer 10* and *G* compatible capabilities and used as a full backup to DSS 51, Johannesburg, South Africa.

A study was made on the Jupiter encounter trajectories provided by the Project. The results indicated that DSN can handle the worst-case doppler variations. Special equipment and procedures will be required to acquire and maintain two-way lock with the spacecraft. It was also determined that the large doppler frequency shift will require new voltage-controlled oscillators (VCOs) in ground receivers during the cruise phases. It was also established that the Project encounter sequence planning of the flight/ground interface needs more detailed analysis in order to ensure the proper support.

The procurement of small computers identified as data decoder assemblies (DDA) was necessary to perform sequential decoding at the deep space stations. The implementation schedule was tight in order to meet the *Pioneer 10* launch readiness date.

An intensive software documentation exchange between the Project and DSN was necessary for the development of the software for the SFOF Central Processing System. There has been a continuing problem in attempting to understand and define the software interfaces inside the CPS.

During the first three months of CY'71, the DSN Interface Engineering Team reviewed in detail all schedules necessary to establish a *Pioneer 10* launch readiness status. The schedule review has shown that the operational readiness date for the 26-m network had slipped from October to mid-December 1971, due primarily to late delivery of the TCP software and DDAs. This condition was caused by a manpower resource constraint. It was also established that the SFOF operational readiness date had slipped to November 1971, due to delays in definition of Project/DSN software interfaces and the delivery date of Project software for integration by September 1, 1971. It was seen at that time that the start of MOS testing would slip, and the total network testing would not start until January, 1972. It was also obvious that the DSN would have to combine the mission-independent and mission-dependent testing and training. It was established that the earliest date for complete transfer to DSN operations would be Jan. 1, 1972, with a more likely date of mid-January, which would mean that the testing and training originally planned for five months was contracted to less than six weeks.

During CY'71, the building construction and equipment implementation for the mission support area was on schedule. A Conscan project quarterly report was issued in January 1971. This report indicated that DSN could satisfy Project-documented Conscan requirements with the existing hardware and software, and the DSN requirements for the support of the Conscan ground backup systems could be satisfied with TCP operational software and new station procedures. Special tests were performed at Goldstone DSCC to determine the effects of a rotating right circularly polarized antenna on the deep space station subsystems. In addition, plans were made to analyze amplitude modulation tracks during *Pioneer 9* superior conjunction to better understand the effects caused by the solar plasma. Data analysis of DSS 14 tracks of *Pioneer 9* to evaluate amplitude modulation effects was completed and information forwarded to the Project.

The milestone schedule published during the third quarter of CY'71 for the deep space stations showed that they would be ready for operations transfer to DSN by mid-December 1971.

During CY'71 the definition of the DSN/Flight Project software interface within the Central Processing System had been defined as a major problem area. Attempts to define this interface in detail were delayed due to available man-power constraints and the high priority of the software testing necessary for MM'71 encounter.

DDAs necessary for sequential decoding were installed at DSSs 11, 42, 51, and 61 in November 1971.

During the second quarter of CY'71 the DSN installed the S-band RF link between CTA 21 and TRW, and an agreement was reached on the DSS/Spacecraft Compatibility Test Plan. It was expected to perform the first RF portion of the test during August 1971.

Further tests necessary for Conscan support have indicated that the expected degradation of doppler and telemetry data will be small and all data will have an acceptable quality. Plans were developed to simulate the Conscan signal for training of DSS personnel by using a function generator to control a modulator in the radio-frequency test signal path.

To establish the RF amplitude stability at DSSs 11, 42, 51, and 61, and to train the personnel in the use of software analysis programs and measurements techniques, a cognizant engineer visited these stations. All tests and data analysis verified that DSN satisfied the Project-documented Conscan requirements. Demonstration tests of the DSS/Conscan compatibility were included in the standard DSN/Spacecraft Compatibility Test Program.

The DSN and the *Pioneer* Project reviewed the software development plan of the Central Processing System and a decision was made to support the *Pioneer 10* launch essential requirements with the Model 5 real-time software. As a part of the software development activities, the following documents have been approved and published:

(1) DSN/*Pioneer 10* Project Technical Software Interface Document.

(2) Management Plan for *Pioneer F* Software Development.

(3) DSN/*Pioneer F* Software Implementation Plan.

(4) DSS to SFOF Interface Documents for Telemetry, Tracking, and Command Systems.

(5) Detailed Milestone Schedules for monitoring the software development.

In mid-CY'71, the construction of JPL Building 264, necessary for the *Pioneer* Mission Support Area, was completed and an agreement was reached with the Project on the layout. DSN also secured a 9300 terminal for the Project's Navigation Team.

The DSN's Ground Communication Facility completed their Operating Procedures and Communications Configuration Plan for *Pioneer 10.* All equipment, including high-speed data lines, were installed and tested. The DSN loaned to *Pioneer* Project a high-speed data encoder/decoder and block multiplexer set from the Compatibility Test Station, DSS 71, Cape Kennedy. This equipment was used by the *Pioneer* Project until their vendor delivered their final high-speed data equipment. The loan equipment was returned to DSS 71 in December 1971.

Network training started with orientation lectures given to DSS and SFOF personnel, and training of key station personnel was carried out during September and October 1971. The *Pioneer* Project Manager and the DSN Manager briefed and reviewed the planning of all DSN Stations.

Special documents describing in detail the DSN/Remote Information Center interface have been published and meetings were arranged to plan for and document the contents and generation of network data records.

An agreement between GSFC/STDN and DSN was made and documented on the support by the Ascension Island station (STDN). Decision was made that the *Pioneer 10* commands will be inputted manually by the station computer for transmission to the spacecraft and the station telemetry system was also made compatible with the *Pioneer 10* spacecraft design. To assure spacecraft/Ascension Island configuration compatibility a special test was made later at Cape Kennedy between the spacecraft operating at Hanger AO and the STDN/Merritt Island Launch Area (MILA) station.

During October 1971, the coding and intensive testing phase of the DSN/360/75 *Pioneer 10* mission-independent software development continued. To assure a *Pioneer 10* launch readiness capability, DSN has negotiated with the *Pioneer* Project a Launch Essential Software Implementation Plan. In view of the interactive complexity of the DSN/360/75 software, its launch readiness status was only established during the latter part of December 1971. Since DSN had available only one Central Processing System with one spare computer, machine and facility time necessary for *Pioneer* software development was very limited during MM'71 orbit operations starting in October 1971.

In November 1971, the *Pioneer 10* launch essential software development of the 360/75 and the TCP continued at a slow pace because of the high activity of MM'71 work load and manpower resource constraints. The launch readiness status of the software was still uncertain at that time.

During the last two months of CY'71 it was obvious that the short lead time available for the development of the large real-time software for the support necessary for MM'71 and *Pioneer 10* taxed every member of the software development team. The coding of the *Pioneer 10* launch essential software was in the completion phase and an intensive facility test program started, which was constrained by limited test time. The combined DSN Network Integration and *Mariner/Pioneer* System Tests were scheduled during the second part of December 1971 with a completion date of latter part of January 1972. It was obvious that because of CPS computer test time constraints, DSN testing and training would be limited.

In the meantime, GCF and NASCOM completed all ground communications circuits and the *Pioneer* Mission Support Area was tested and declared operational. In addition, initial testing of the Remote Information Center's telemetry interface between the 360-75 and ARC was started. Review copies of a preliminary *Pioneer F* and *G* NASA Support Plan (NSP) were distributed for review and the original document was forwarded for endorsement.

In January 1972, the intensive testing and training of all TDS facilities were underway with the objective to be ready for a nominal *Pioneer* launch support capability by February 1. It was planned to start at this time the Project's Mission Operation System testing. The implementation schedule of the sequential decoding hardware and software at DSSs 42 and 61 had shown further delays with some positive hope of having this capability ready by the launch of *Pioneer 10.*

The Spacecraft/DSN RF and Data System Compatibility tests were performed between the prototype spacecraft at TRW/CTA-21/JPL during August and November 1971 and between the flight spacecraft at TRW and CTA 21 in December 1971. The compatibility verification tests using the flight spacecraft located at Cape Kennedy and DSS 71 were performed on 1/31, 2/1, 2/2 and 2/21 of 1972. A few software compatibility discrepancies were noted and corrected.

The DSN and Project test support summary is given in Fig. 7. The implementation of this busy schedule was only possible because the MM'71 Project agreed to process their spacecraft data together with *Pioneer 10* data streams using the same real time software in one of the 360/75 computers. This configuration met the original objectives to operate *Pioneer* and *Mariner* in the same 360/75 in a multimission mode to free the second machine for further software development and testing and also backing up the maintenance of the prime machine.

During flight operations, the prime control of the DSN and the direct operational interface with mission control was exercised by the Operations Control Team. This team consisted of an Operations Control Chief and an Operations Chief from each DSN facility. Supporting at this time were operations groups representing each DSN system, the Deep Space Stations, communications facilities, and the SFOF Central Processing System. Figure 8 displays the DSN operations organization as it was configured during and after *Pioneer 10* launch support. Bringing the network up to a *Pioneer 10* launch support readiness status was the result of systematic planning and coordination work carried out by the members of the *Pioneer*/DSN Interface Engineering Team. This team held for almost two years regular biweekly Operational Support and Planning Group meetings. Each meeting had a prearranged agenda and followed up the status of the development of DSN System Engineering, Data Processing, DSIF, GCF and SFOF operations. The meetings were chaired by the DSN PE assigned to the *Pioneer* Project who assigned regular action items to the members of the team. The same team was also responsible for generating and publishing most of the DSN documentation necessary for the orderly preparation of the support of the first Jupiter mission. Twenty-six formal *Pioneer 10* and *G* documents were published, including five Tracking and Data System Progress Reports. These documents were distributed to all DSN personnel engaged in the *Pioneer 10* and *G* support activities and also to the interfacing members of the Flight Project Engineering Team. A detailed account on the described *Pioneer 10* and *G* support planning activities and on the *Pioneer 10* launch will be given in a final report entitled *Tracking and Data Systems Support for the Pioneer 10 Mission, Volume I*. This report will also include a description of the planning and support activities of the Near-Earth Network.

III. *Pioneer 10* Launch

Following a Mission Readiness Review that was held on Feb. 22 at Cape Kennedy, the launch vehicle was subjected to an RF interference test followed by the spacecraft RF signal strength measurement. DSN compatibility test station, DSS 71, supported this activity and validated the design thresholds of the S-band uplink and downlink. On February 26, four radio-isotope thermoelectric generators (RTGs) were installed on the spacecraft. These will provide the principal source of electrical power to all onboard systems and scientific instruments. During the same time, the flight battery was installed and the spacecraft was secured for the countdown.

On March 3, 1972, 01:49 GMT the first *Pioneer* spacecraft destined for Jupiter and beyond was launched from Cape Kennedy. The launch was successful after three previous attempts on Feb. 27 and 28, and March 1, which were canceled because of high winds in the upper atmosphere. All three stages of the launch vehicle performed nominally, and the injection was within a one-sigma dispersion.

The initial DSN down-range acquisition was accomplished by DSS 51 at Johannesburg, South Africa. This station established S-band telemetry downlink contact with the spacecraft twenty two minutes after launch. After the two-way S-band acquisition was completed as planned, the *Pioneer* operations team started to send commands to the spacecraft twenty-six minutes after launch. At the end of the view of DSS 51, the STDN Station at Ascension Island took over the support for one hour to close the gap between the views of Johannesburg DSS, and Goldstone DSCC. This gap was caused by the low declination angle (−33 deg) of the spacecraft trajectory. Nine hours after launch DSS 11 established two-way contact, and at the end of the California view, DSS 42 in Weemala, Australia, tracked *Pioneer 10* and tied the next tracking and data acquisition pass into Johannesburg.

This typical sequence followed during the second, third, and fourth days after launch with the addition that on the third day DSN also provided support from DSS 14, the 64-m antenna station at Goldstone DSCC, which was used to enhance velocity correction measurements. The Project fired the velocity correction thrusters of the spacecraft for a short time, and DSSs 11 and 14 furnished the telemetry, tracking and command capabilities necessary to make these calibration measurements possible.

During the successful launch of *Pioneer 10* all prime backup facilities operated as planned, and DSN furnished real-time telemetry information almost continuously for the flight control team and for the principal investigators of the scientific experiments. The flight control team transmitted 175 commands during the first 72 hours of flight. DSN also provided two-way precision doppler data which were used by the navigation team to establish and update the spacecraft solar orbit and to prepare for the midcourse maneuvers.

On the sixth day of flight, the first midcourse maneuver was performed. The primary objective of the maneuver was to move the encounter target zone to three radii from the center of Jupiter, 14 deg below a parallel to the ecliptic through the planet center. The periapsis arrival time was placed within the views of the 64-m antennas at Goldstone DSCC, and Canberra, Australia. These conditions would satisfy the design objectives of the science experiments and would ensure against failure to receive data at either tracking station at the most critical hours of data acquisition. Based upon a priority list previously made with the experimenters and upon subsequent analysis, preference was made to attempt occultation by a Jupiter satellite, Io, or closely approach satellites for telemetry imaging. These goals were in addition to accommodating the primary objectives.

During re-orientation of the spacecraft-to-Earth alignment after ejection, signal dropouts were experienced in the interference region between forward and aft spacecraft antennas; therefore, as expected, the maneuvers were restricted to within 45 deg of Earth alignment. Also, equipment compartment temperatures were near the upper design limits, so it was decided to not turn the spacecraft backside toward the Sun during this maneuver. The maneuver strategy was selected 48 hours after launch and sustained by the excellent performance of the propulsion system and DSN's measurements during calibration maneuvers in the ensuing 15 hours.

The aim of the combined first and second midcourse maneuvers was to time the arrival for Dec. 4, 1973 at 02:26 GMT when Io would occult the spacecraft and some optical observations of satellites would be possible. The first midcourse maneuver was accomplished by precessing 45 deg from the Earth line into a plane containing the required velocity vector and the Earth line, accelerating the spacecraft to a velocity increment of 18 m/s away from the Earth and returning to the Earth line with 9 m/s toward Earth.

On March 24, on the 21st flight day of *Pioneer 10,* the second midcourse maneuver was executed. The midcourse maneuver was accomplished in two components lying very nearly in the spacecraft Earth/Sun plane. The first was directly away from the Earth 1.8 m/s and the second was 2.14 m/s, 24 deg off the Earth line away from the Sun and generally toward the Earth. The Earth line component was trimmed to within an estimated 0.3 mm/s upon completion of the maneuver. The spin axis was then turned 10 deg away from the Earth line toward the Sun to minimize the equipment heating.

Figures 9, 10, and 11 display the relative Earth and spacecraft trajectories and positions, the initial and second midcourse maneuvers, and the DSN support.

IV. *Pioneer G*

After the launch and first 30 days support of *Pioneer 10* the DSN Interface Engineering Team and the implementing and operations organizations started the planning for the launch of *Pioneer G.* The launch window of this spacecraft opens April 5, 1973 and closes April 17, 1973. This mission will use a direct-ascent trajectory with an Atlas/Centaur TE 364-4 launch vehicle. The initial flight azimuth will be 108 deg with a yaw steering of 107 to 127 deg. This corridor will encompass declination angles from −33 deg all the way down to −42 deg.

V. *Pioneer* Venus

During the latter part of 1971, NASA Headquarters transferred the project management of the *Planetary Explorer* from Goddard Space Flight Center to the Ames Research Center and renamed the *Planetary Explorer,* "*Pioneer* Venus." This new group can be identified as the fourth-generation *Pioneers.*

The scientific communities are beginning to see Venus as at least equal in scientific importance to any other object in the solar system; therefore, they feel that the exploration and understanding of Venus should be a high priority item in NASA's planetary exploration program. Venus is Earth's closest neighbor in the solar system. Similar to Earth in size and proximity to the Sun, and possibly similar to Earth in origin, Venus' extremely dense atmosphere, uniform cloud cover, high surface temperature and very low rotation rate make it one of the strangest in the planetary system.

Man's recent knowledge of the Venus environment is based upon the measurements performed by *Mariner 5* and *Venera 4, 5,* and *6. Mariner 5* provided the information on the pressure and temperature near the surface of Venus and the distribution of electron density in the day and night side ionosphere and the termination of the daytime ionosphere by the solar wind. *Mariner 5* has also shown that Venus has a hydrogen corona and may have deuterium in its upper atmosphere. Magnetic field and particle measurements demonstrated that Venus has virtually no magnetic field. Venera spacecraft measurements confirmed this result.

The basic results of the *Planetary Explorer* studies were summarized in a GSFC Document, entitled *Phase A Report and Universal Bus Description*, dated May 1971. This study recommended two *Planetary Explorer* launches using multiple entry probes, followed with a Venus Orbiter mission, and the last mission would be again a multiple entry probe type.

The objectives of the entry probe missions were:

(1) Nature and composition of the Venusian clouds.

(2) Composition and structure of the atmosphere on the surface to high altitude.

(3) General circulation pattern of the atmosphere.

The proposed orbiter mission objectives were:

(1) Measurement of the detailed structure of the upper atmosphere and ionosphere by *in situ* techniques.

(2) Investigation of the interaction of the solar wind with the Venus ionosphere in the magnetic field in the vicinity of the planet.

(3) Determination on a planetary scale of the characteristics of the Venus atmosphere and surface by remote sensing experiments.

(4) Determination from orbiter perturbations of gravitational field harmonies.

On January 10, 1972, GSFC arranged for an Ames/*Pioneer/Planetary Explorer* briefing. This briefing was attended by the Ames Pioneer Study Team of ARC, *Planetary Explorer* Study Team of GSFC, and the DSN Manager for the *Pioneer* Project.

In February 1972, the ARC Scientific Definition Team of Venus *Pioneers* prepared a request proposal on the Phase B Study of the Venus *Pioneers*. In March qualified aerospace companies were invited to submit their study proposals.

ARC plans to review completely the contents of the Phase A study and change or simplify the proposed design. It is assumed that the TDA requirements will also be affected.

The Phase B Study will require six to nine months to be completed. After the scientific details of the missions have been identified and the functional spacecraft design and the mission profiles have been iterated, ARC plans to ask NASA Headquarters to get a formal approval of the official start of the Venus/*Pioneer* missions. This approval will be endorsed by a Venus *Pioneer* Project Approval Document (PAD).

References

1. Siegmeth, A. J., "*Pioneer* Mission Support," in *The Deep Space Network*, Technical Report 32-1526, Vol. V, pp. 4–16. Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1971.

2. Siegmeth, A. J., "*Pioneer* Mission Support," in *The Deep Space Network*, Technical Report 32-1526, Vol. VI, pp. 13–24. Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1971.

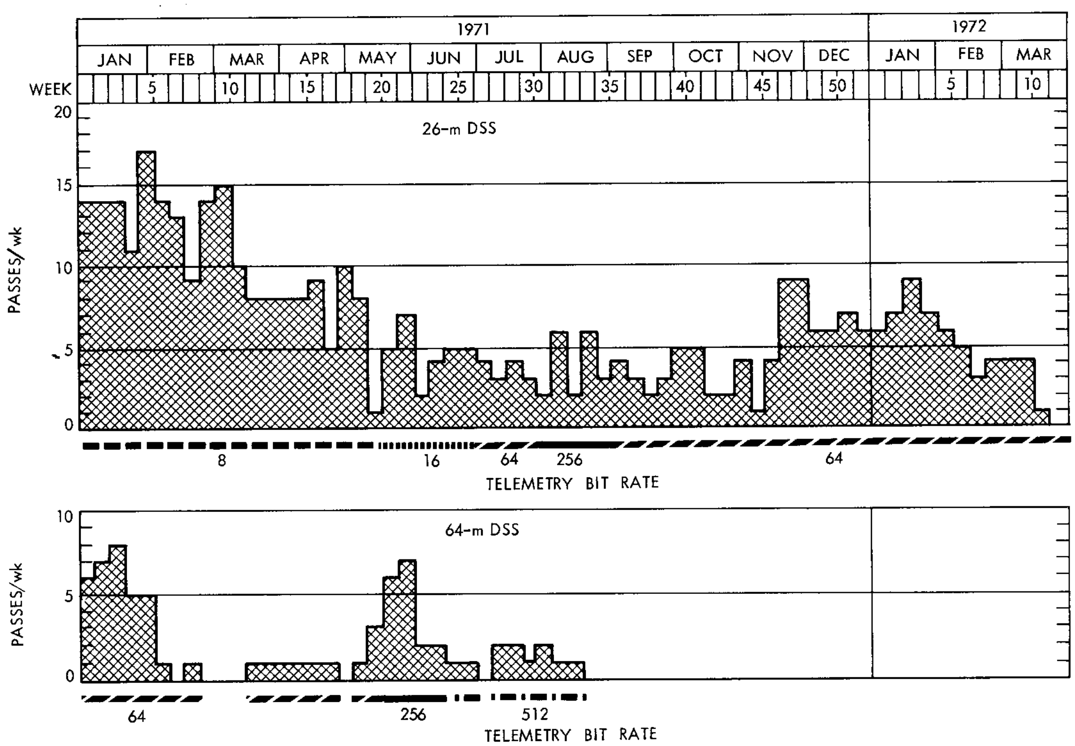

Fig. 1. *Pioneer 6* actual DSS passes

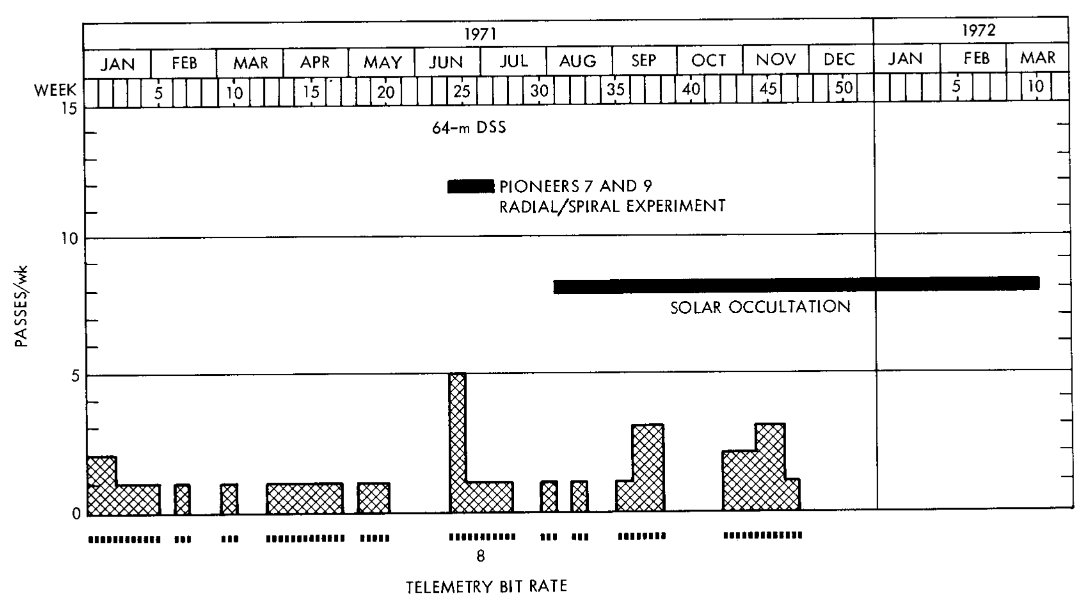

Fig. 2. *Pioneer 7* actual DSS passes

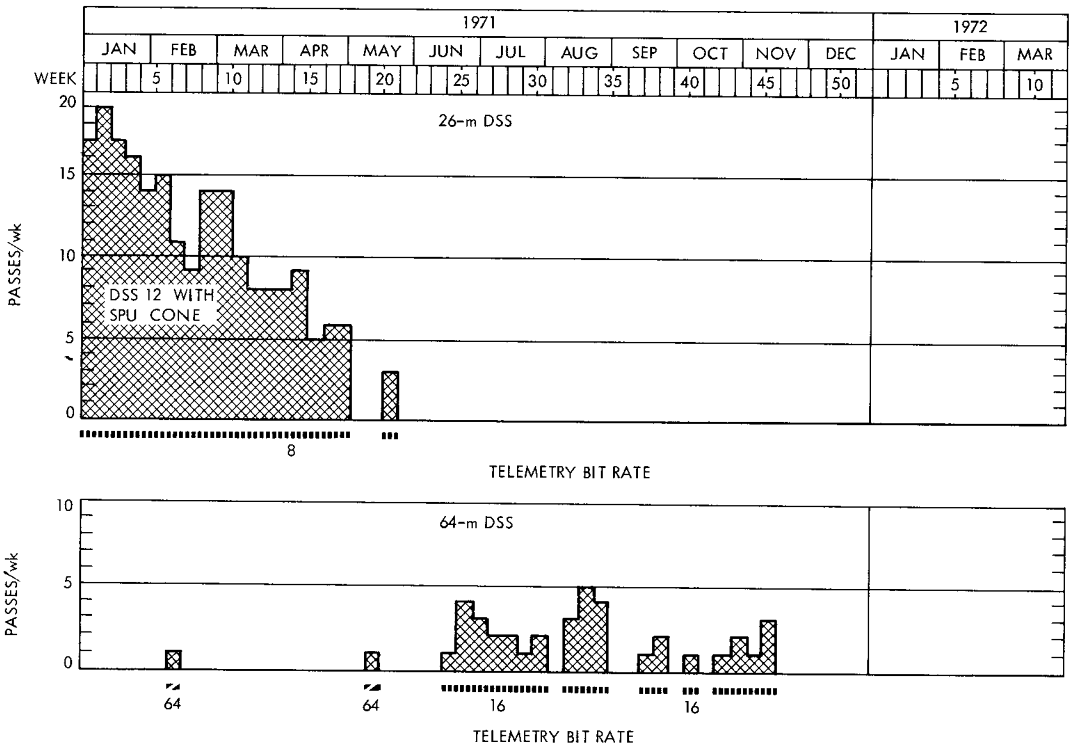

Fig. 3. *Pioneer 8* actual DSS passes

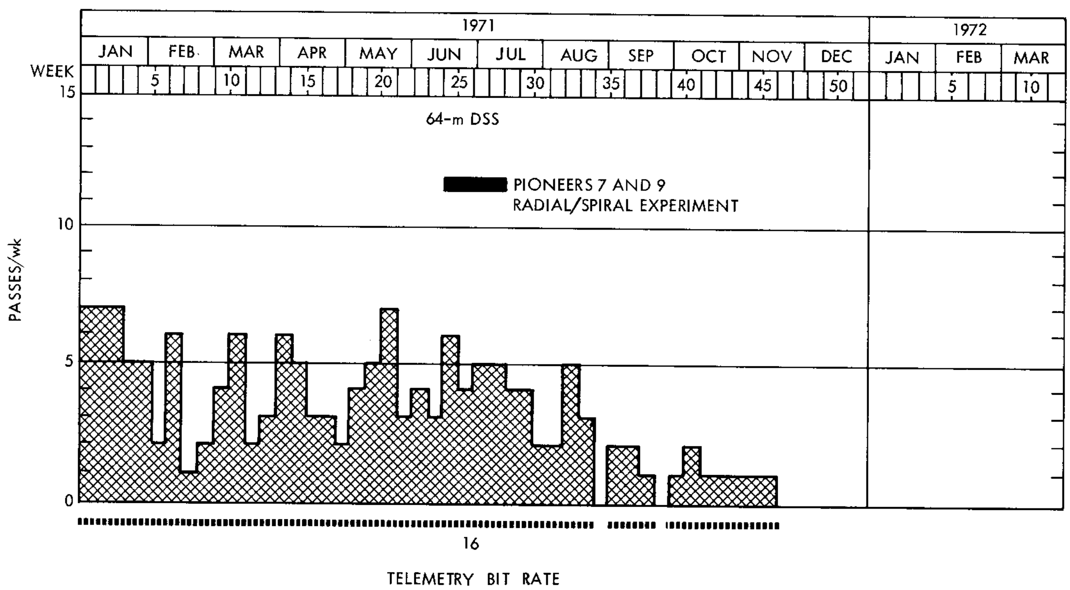

Fig. 4. *Pioneer 9* actual DSS passes

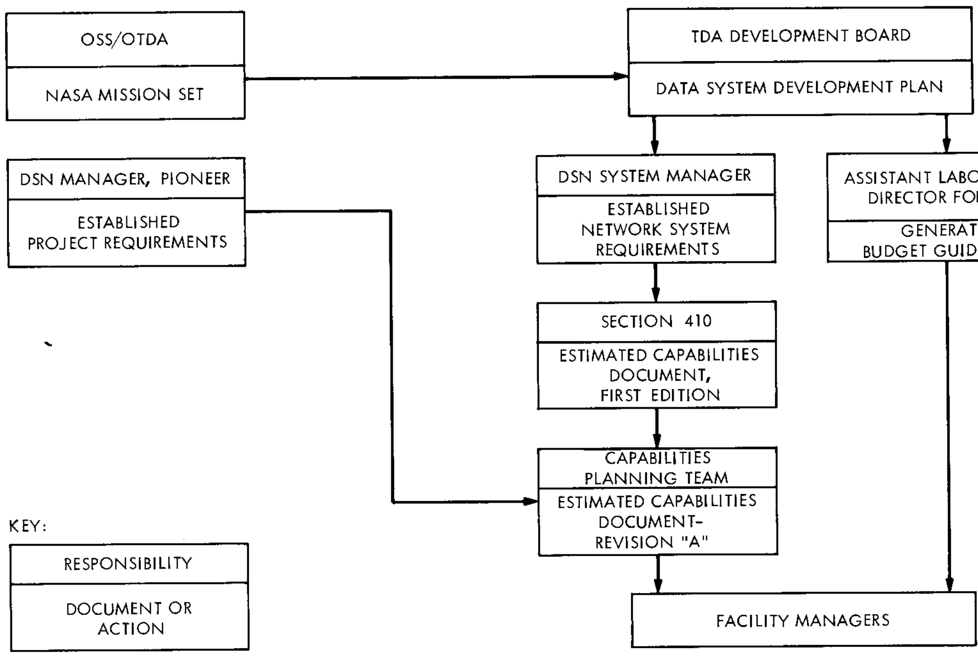

Fig. 5. *Pioneers 10* and G DSN planning activities

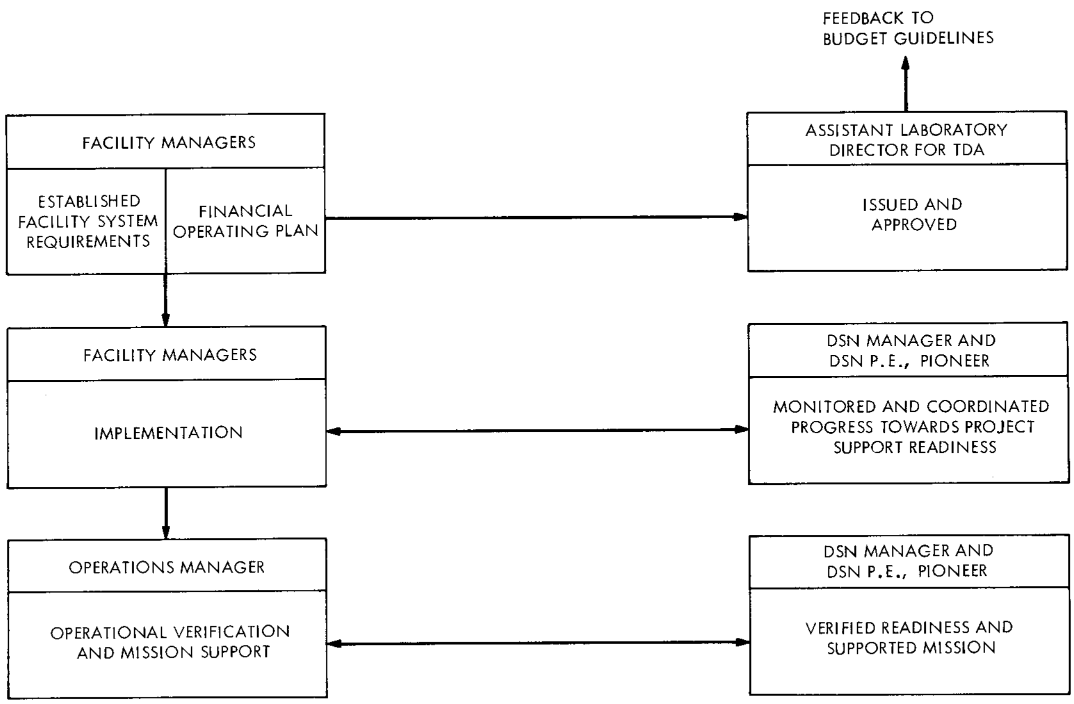

Fig. 6. *Pioneer 10* and G DSN implementation activities

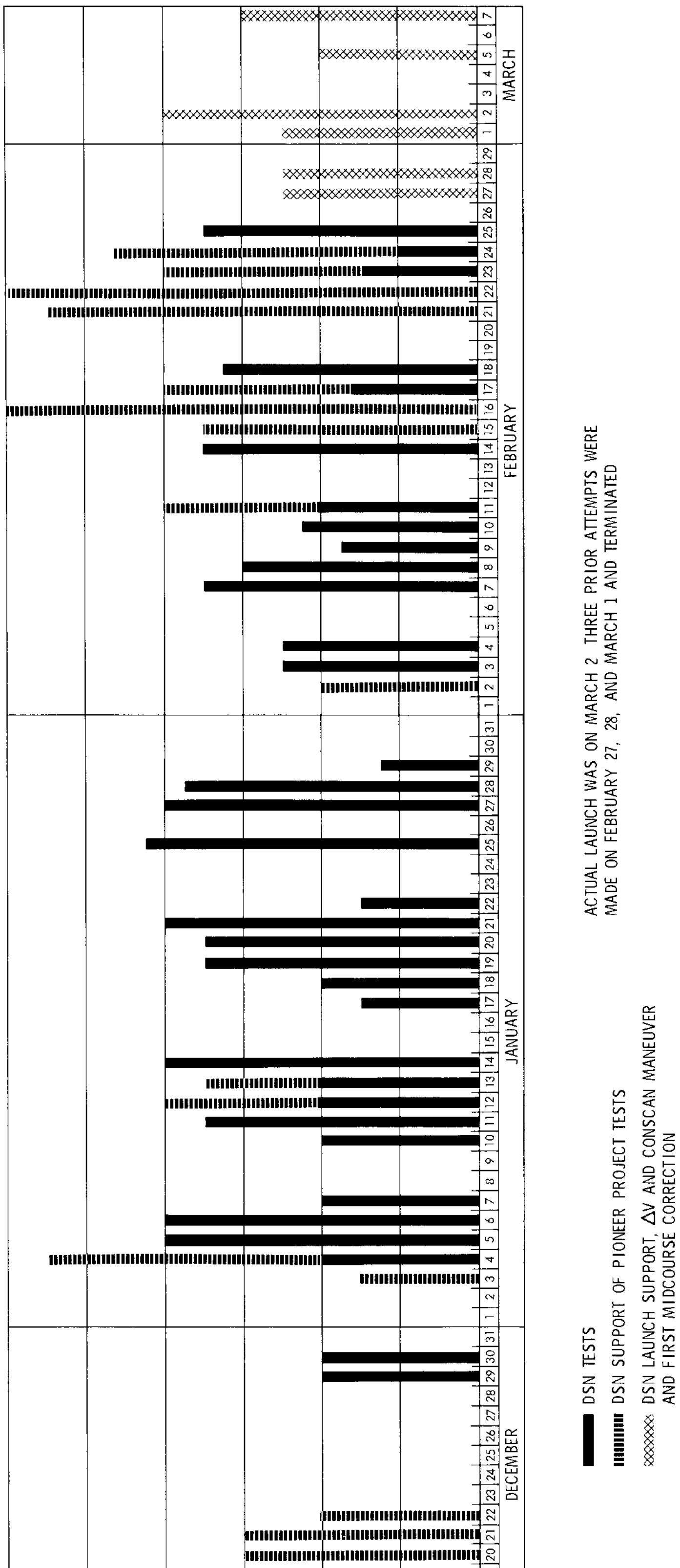

Fig. 7. *Pioneer F* DSN and project test support summary

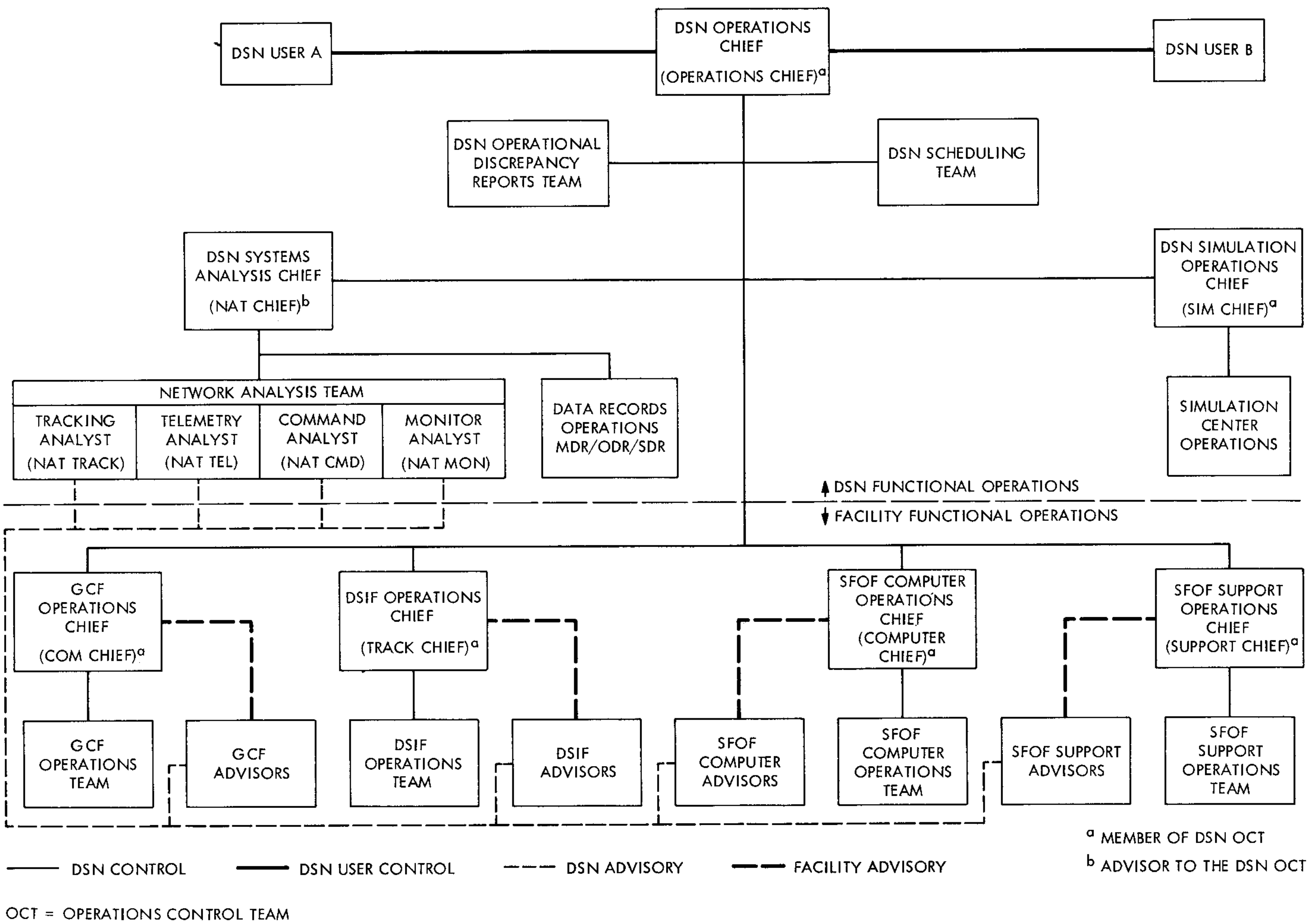

Fig. 8. DSN operations organization

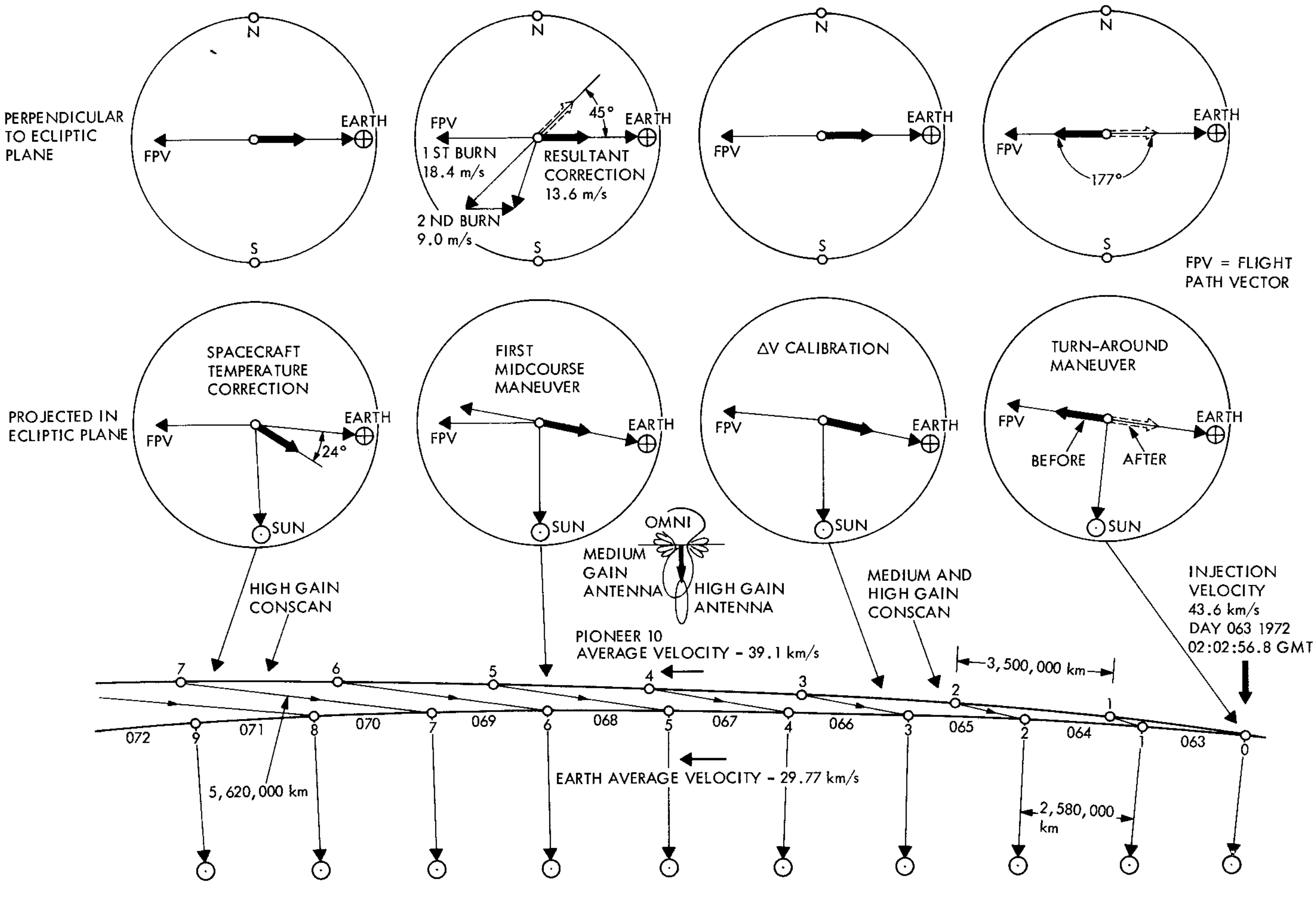

Fig. 9. *Pioneer 10* initial maneuvers

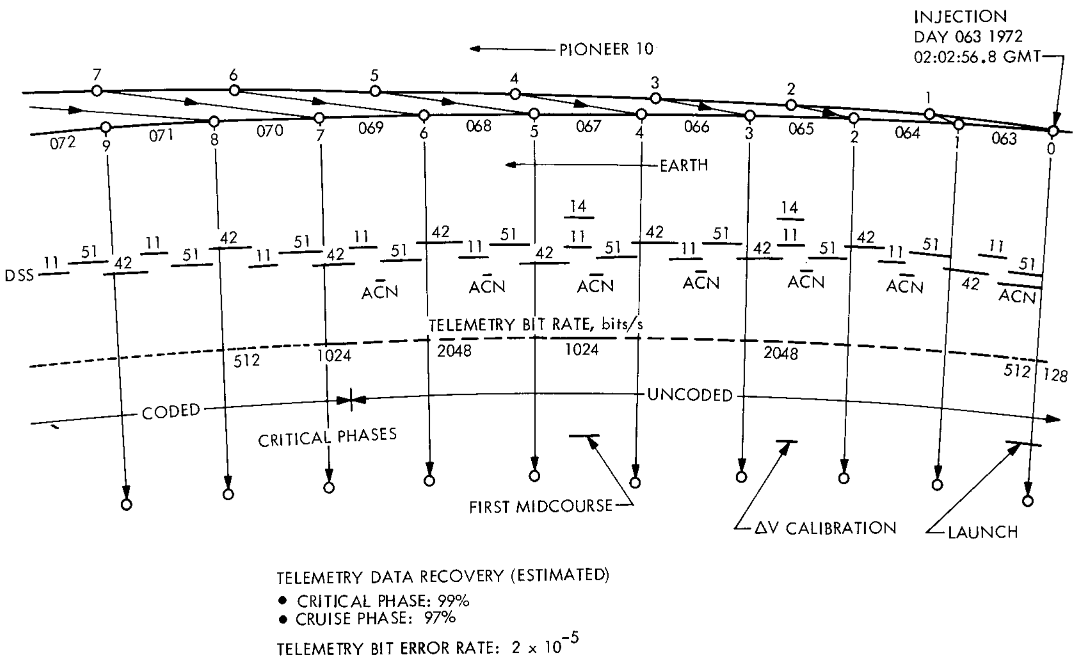

Fig. 10. DSN support

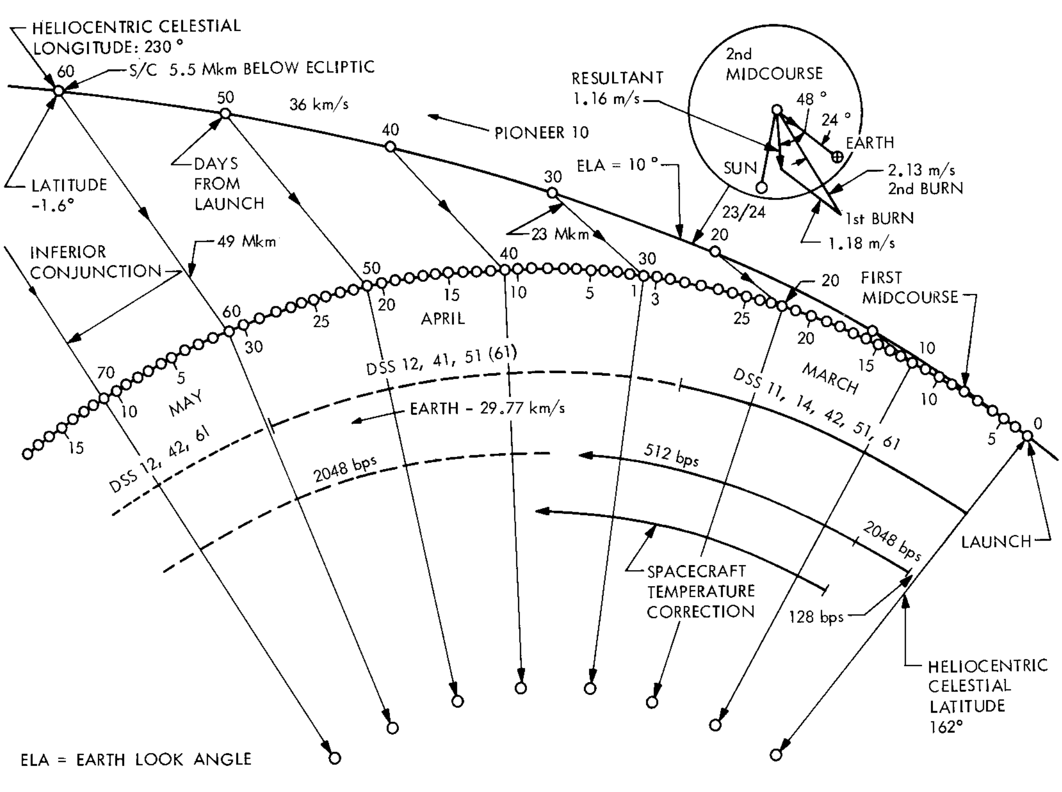

Fig. 11. *Pioneer 10*, first 60 days of flight