DSN Research and Technology Support

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The activities of the Venus Station (DSS 13) and the Microwave Test Facility (MTF) during the period October 11, 1976, through February 13, 1977, are discussed and progress noted.

A significant effort on implementation of equipment for the planned conversion of DSS 13 to unattended operation is discussed. The Receiver and Microwave Subsystem are near completion, and the new feedcone and position encoders have been implemented onto the 26-m antenna. Support of the 400-kW X-band radar, located at DSS 14, is reported, and the activities of the DSN High Power Transmitter Maintenance Facility (HPTMF), located at DSS 13 and MTF, are discussed. The successful completion of the first series of observations planned for VLBI validation is reported and significant station maintenance activities are briefly covered.

Clock synchronization transmissions to DSS 43 and DSS 63 are reported, and an evaluation of any pointing errors in the new 26-m antenna position transducer are made. Extensive tracking support for various Advanced Systems Development and Ground Based Radio Science activities is reported. In particular, VLBI observations for DSN platform parameters, interplanetary scintillation of signals from the Viking spacecraft at small SEP angles, planetary radio astronomy, radio frequency interference analysis, and geo-stationary satellite radar cross section experiments were supported and are discussed.

I. Introduction

The activities of the Development Support Group, in operating the Venus Station (DSS 13) and the Microwave Test Facility (MTF) during the period October 11, 1976, through February 13, 1977, are discussed.

II. Unattended Operation, DSS 13

A. Receiver and Microwave Subsystem Automation

The receiver front ends have been installed into the electronics room of the DSS 13 26-m antenna. Interfacing with the maser has been accomplished and operation has been verified with temporary cabling. The microcontroller for control of the waveguide switching has been installed and operation verified. The modified PDS feedcone, now identified as the S-band Venus unattended (SVU) feedcone, has been installed onto the 26-m antenna. Inasmuch as this is a 64-m feedcone, a special adapter ring was necessary to physically mount this cone and fill the open space on the antenna surface which was left bare.

B. Transmitter Subsystem Automation

In anticipation of the future automation of the uplink, additional wiring was added to the transmitter remote control cabinet (located in the Operations and Data Processing building) and documentation updated as necessary. The temperature and pressure transducers, with which operation of the transmitter cooling system will be monitored, have been tested and the results made available to the design engineers.

C. Antenna Subsystem Automation

The original position encoders with which the 26-m antenna was equipped have been removed and replaced with a new design transducer which provides 20-bit (1 part in 1,048,576) resolution. These new transducers have been temporarily interfaced with the station SDS-930 digital computer to provide an interim tracking and conical scanning capability pending complete implementation of a new antenna control and pointing computer.

D. 26-m Antenna Pointing System Evaluation

The introduction of a new position transducer into the 26-m antenna subsystem required evaluation of any pointing errors which might be present. Using an automatic boresighting computer program called SCOUR (*S*can and *CO*rrect *U*sing *R*eceiver), 22 hours of pointing evaluation were performed using radio sources as targets. An initial series of observations resulted in a nominal azimuth offset of +0.150 deg and an elevation offset of −0.015 deg. The transducer was adjusted to remove this offset and a new series of observations have commenced.

The new antenna control and pointing computer, a MODCOMP, has been installed and interfaced with the servo system, but software checkout has not yet been accomplished. This checkout is being slowed by an intermittent problem which has cropped up with the new encoders. Although several successful tracks have been performed with the new encoders and the SDS-930, a problem has recently surfaced wherein the encoders exhibit a "jump" in indication. Readjustment of the coarse and fine synchro-/resolvers is in progress to correct this problem.

III. X-band Radar, 8495 MHz, 400 kW

In support of a major effort to realize a reliable 400-kW X-band radar, significant testing and on-site support at DSS 14 has been provided by the Development Support Group. Testing included full power testing, on an expedited basis, of two VA949J klystrons (S/N 33R1 and 32R2) at the 200-kW power level. On-site support included trouble shooting and repair of the buffer amplifier, as well as disassembly and reassembly of the final amplifier(s) and transportation by JPL aircraft of the defective klystrons to and from the vendor for repair.

IV. Deep Space Network High Power Transmitter Maintenance Facility (DSN HPTMF)

The protective circuits (arc and body current detectors) with which the DSN high power transmitters are equipped must act very rapidly (within microseconds) when a fault condition develops. Extensive measurement of the "time to perform" of the spare and installed detectors was performed at DSS 13. Additionally, three arc detectors, two photon generators, one filament power monitor and various logic cards which had failed in service were repaired and operation verified at the HPTMF.

Other testing activities included acceptance class testing of three DSN 20 kW (5K70SG) klystrons and delivery of them, as needed, to DSN Logistics Facility for shipment to the stations.

V. VLBI Validation

In support of the implementation of VLBI into the DSN as an operational technique, several demonstrations of short and long baseline length determination are planned. DSS 13 will play an active role in this series of demonstrations and additional equipment was necessary.

For Experiment 1, the data gathering technique required utilization of an SDS-920 digital computer, with which DSS 13 is not equipped. A computer, previously used at DSS 12 as the TCP, was installed at DSS 13 by station personnel and checked out using the special program required for VLBI data collection. A wide band (40-MHz instantaneous bandwidth) maser was also a requirement, and a development maser, which is also tunable from 2270 to 2388 MHz, was installed and interfaced with station receivers.

With this new equipment, and with a special receiver furnished by the Validation Project, DSS 13 successfully supported Experiment 1, Run 1 and Experiment 1, Run 3 for a total time of 22.5 hr. The first run was made using the old feedcone, and the last run was made using the new SVU feedcone described previously (*DSN Progress Report 42-36*, pp. 153-156). With the completion of Experiment 1, the SDS-920 computer is no longer needed and will be disposed of through appropriate channels.

VI. Station Maintenance

During the last month of use of the old 26-m feedcone, additional maintenance was required on the maser refrigerator, but installation of the new tunable wideband maser and overhaul of the associated maser compressor has apparently produced a reliable system, as no problems have been experienced since that installation.

The 1.2-MW, 70-kV dc Power Supply used with the high-power transmitter developed excessive ripple in the output voltage. Investigation revealed that one or more of the solid-state rectifier assemblies had failed. Baseline performance under test conditions was ascertained for the spare assemblies and a complete replacement was made. The transformer and rectifier tanks were cleaned, the insulating oil was filtered, and the system was restored to service. Wiring changes were made in the over current and phase unbalance protective circuits. Extensive phase voltage and current measurements were also made for future reference in performance evaluation.

The data collection systems of the Faraday rotation and solar and microwave monitoring equipment failed in several areas, but all assemblies have now been repaired and data collection on both punched paper tape (Faraday rotation) and magnetic tape (solar and microwave and Faraday rotation) is now being performed.

VII. Clock Synchronization System

Although troubled by problems at the receiving stations, and, on one occasion, by a transmitter problem a total of 29 transmissions were made as scheduled by DSN Scheduling. Of these, 12 transmissions were made to the DSS 43 complex and 17 were made to the DSS 63 complex, for a total of 29 hr of reception and correlation.

The electrical power input to the control system was interrupted by a failure of one phase of the incoming three-phase power. The connecting lug on the input to the circuit breaker broke and the line came into contact with the panel case. The ground current overheated and melted the safety ground wire and the resulting smoke activated the smoke detectors. The fire department responded in a timely fashion and the station electrician repaired the damage and restored the system to service. No planned testing or transmissions were affected.

VIII. DSN Platform Parameters

VLBI promises to be useful for spacecraft navigation, if a suitable set of calibrated radio sources can be developed. Determination of the flux density and position of this set of radio sources is one of the tasks underway in this Advanced Systems Development experiment. In support of this survey of radio sources, DSS 13 provided 67.75 hr of VLBI observing in conjunction with either DSS 43 or DSS 63. Approximately 330 source observations were made during this reporting time.

IX. USAF Satellite Radar Cross Section

By letter agreement between OTDA and USAF, a series of radar observations of a geo-stationary satellite were made. Using the 400 kW S-band transmitter at DSS 14, the target was illuminated. By frequency shifting the transmitter every round trip light time, reception of the reflected signal at DSS 13 was possible. The received signal was microwaved to DSS 14 for analysis and recording. This project is now complete and DSS 13 provided 12.25 hr of observing during this period.

X. Planetary Radio Astronomy

On a time-available basis DSS 13 provides support to this experiment from the "Ground Based Radio Science Plan." The radiation received from Jupiter at 2295 MHz is measured and its variability determined. A number of radio sources are used as calibrators for this program. A total of 35.25 hr of observing were accomplished during this period, using the 26-m antenna and both RCP and LCP, at an observing frequency of 2295 MHz.

XI. Pulsar Rotation Constancy

Also on a time-available basis, DSS 13 observes pulsars in support of this experiment from the "Ground Based Radio Science Plan." The data collected include pulse rate, pulse-to-pulse spacing, pulse power, and pulse shape. These measurements are made at 2388 MHz, with the 26-m antenna adjusted for LCP. During this period, 48.5 hr of pulsar tracking was performed. These data are normally taken as part of the DSN automation test bed activities. However, at present, data will be taken in the manual mode until the automation test bed is reconfigured in June 1977.

XII. Radio Frequency Interference

With the increase in utilization of S-band, the potentiality for interference with the DSN grows more probable. In support of a program to learn more about this problem, DSS 13 provides observations in special circumstances which might produce interference to the DSN radio frequency systems. A large-scale USAF exercise, which involved extensive utilization of electronic countermeasures, provided such a special circumstance. DSS 13 performed 9 hours of observing, and observed interference from this exercise in the band 2290 to 2300 MHz.

XIII. Interplanetary Scintillation

In support of the Viking science project, DSS 13 performed tracking of the Viking spacecraft as the Sun-Earth-Probe (SEP) angle went through a minimum. The received signals, which were received using a predicted frequency technique and a digital controlled oscillator, had passed through the interplanetary media and, in particular, had passed through varying amounts of the solar corona. The signals were microwaved to DSS 14, which was also observing, for real-time spectral analysis and recording. Four days of spaced observations were provided by DSS 13 for a total of 25.75 hr of observing.