Pioneer Mission Support

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This article reports on some recent activities within the Deep Space Network in support of the Pioneer Project's in-flight spacecraft. The amount of tracking coverage provided by the Network and the current status of operational testing of the Mark III Data Subsystems are presented.

I. Pioneers 6, 7, 8, and 9

Coverage of these spacecraft has continued to be at minimal levels. Pioneers 6 and 9 were tracked a total of seven times during the period from September through November, but Pioneers 7 and 8 were not tracked at all. The only anticipated coverage in the foreseeable future will be limited tracking of Pioneer 7 in February. This will be in support of the spacecraft's passage through the geomagnetic tail, at a range of approximately 20 million kilometers from Earth.

II. Pioneers 10 and 11

A. Mission Operations and Status

Both spacecraft continue to be in excellent health. Tracking coverage has increased recently due to the lessening of other commitments on the Network. Total tracking coverage times appear in Table 1.

On September 20, a failure was detected in the Pioneer 10 high-gain antenna feed movement mechanism. This unit moves the feed to provide a constant offset of one degree against which measurement is made of the actual angular separation between the spacecraft spin axis and the spacecraft-Earth line. The feed assembly is moved by means of a piston traveling within a bellows filled with Freon 21. The bellows burst, allowing the Freon to escape and the antenna feed to return to its normal position. This was not an unexpected failure, since the projected life of the bellows was approximately two years and the spacecraft is now in its fifth year of flight. The backup feed movement mechanism will be used for all future measurements. It should be noted that the Navigation Team was able to detect the failure from radio metric data. The escaping Freon imparted a velocity change to the spacecraft equivalent to a doppler shift of 0.02 Hertz. Such accuracy of detection and measurement is impressive, considering the fact that the spacecraft is more than one billion kilometers from Earth.

The Navigation Team also detected an unexplained velocity change of 0.057 meters/second during a Pioneer 11 precession maneuver on September 15. The reason for the change is unclear, but it may have been caused by one of the thruster jets sticking open, resulting in an excessive pulse length. Subsequent precession maneuvers have been conducted successfully with another pair of thrusters and this pair will continue to be used until the problem is understood.

B. Mark III Data Subsystems Support of Pioneer

Implementation of the Mark III Data Subsystems (MDS) hardware has been completed at the Goldstone Echo Station, DSS 12, and the first in a series of three Pioneer demonstration passes was conducted on December 18. The purpose of the pass was to exercise the station equipment and personnel while in a Pioneer 11 flight support configuration.

The pass was structured to closely resemble a typical Pioneer track. Activities included standard downlink and uplink acquisitions, the processing of telemetry at several bit rates and frame lengths, the transmission of commands to the spacecraft, and the generation and transmission of monitor and radio metric data to the Network Operations Control Center (NOCC). The initial station configuration used for the pass is shown in Fig. 1.

A successful data transfer test was completed prior to acquisition for command, radio metric, and telemetry data. Monitor data could not be verified due to the absence of the appropriate NOCC software. The station acquired the downlink signal in a three-way mode with DSS 61 in Spain, accepted a transfer of the uplink, and commenced commanding. Three remote mode commands were generated by the Project and transmitted from the station. Although spacecraft response to these commands was verified by the Project, no such response was observed for a bit rate change command which the station had transmitted locally. It was later determined that this was due to an incorrect hexidecimal command value that had been provided by the Project.

Two telemetry frame size changes and two bit-rate changes were processed by the station without serious difficulty. However, some problems were discovered in the preliminary operational procedures for effecting these changes. Some minor procedural problems were also experienced with the operation of the Metric Data Assembly, but it is felt that such problems are to be expected in the early phases of training and should disappear as operator familiarity increases.

Operational software did not exist in the NOCC for handling monitor data from an MDS-equipped station and the station software did not include a recall capability. Both of these functions will be fully verified during later operational testing with DSS 12 as software development continues.

Table 1. Pioneer tracking coverage

	Spacecraft	Station type	Tracks	Tracking time, h:min
September	Pioneer 6	26-meter	1	5:22
	Pioneer 10	26-meter	30	127:51
		64-meter	1	8:53
	Pioneer 11	26-meter	39	290:37
October	Pioneer 6	26-meter	1	3:56
	Pioneer 9	26-meter	3	12:50
	Pioneer 10	26-meter	30	195:04
		64-meter	6	44:02
	Pioneer 11	26-meter	40	274:43
November	Pioneer 6	26-meter	2	8:18
	Pioneer 10	26-meter	39	298:23
		64-meter	22	145:18
	Pioneer 11	26-meter	50	407:35
		64-meter	6	41:59

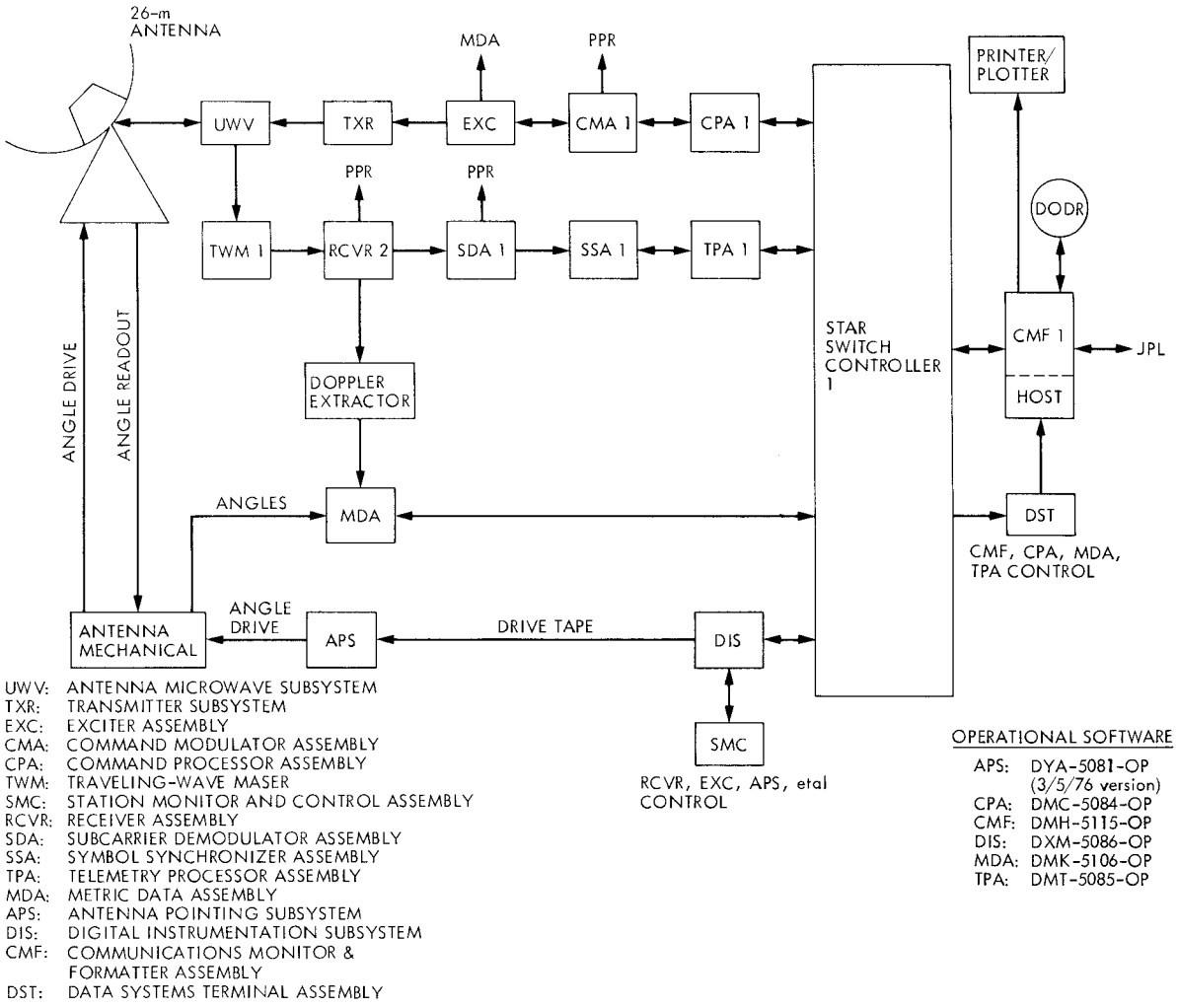

Fig. 1. Standard Pioneer configuration—DSS 12