Viking Extended Mission Support

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This article covers the period from May 1 through June 30, 1978. It reports on DSN support of Viking spacecraft activities during the period and continues reporting on the DSN Viking Command and Tracking support.

I. Introduction

A. Status

The Viking Orbiter 1 (VO-1) spacecraft continued to operate as expected during this reporting period as it collected and returned to Earth weather data and Mars photos as well as relaying to Earth data from the two Viking Landers.

Due to serious gas leaks in the roll-axis control jets the Viking Orbiter 2 (VO-2) spacecraft continued, during the major portion of this reporting period, in a roll drift mode of operation. In the roll drift mode of operation the roll control jets are disabled, allowing the spacecraft to slowly roll as it revolves around Mars. During the roll drift mode the VO-2 spacecraft cannot observe Mars with its science instruments. However, engineering data monitoring the status of the spacecraft continues to be transmitted to Earth.

On June 17 and continuing for an eight-day period, the VO-2 spacecraft was brought out of the roll drift mode of operation to obtain water vapor and temperature measurements in a high latitude region of Mars. VO-2 was returned to a roll drift mode of operation to conserve its nearly exhausted supply of attitude-stabilizing gas for one more science sequence, starting 20 July.

Both Viking Lander spacecrafts (VL-1 and VL-2) were placed in a six-month automatic mode of operation (VL-1 on May 25 and VL-2 on June 15 during this reporting period). During this six-month period few or no instructions will be sent from Earth. Both Landers will send periodic information about weather, soil chemistry calibrations and some photos, mainly to check hazes and clouds in the martian sky.

B. First Commanding from On-Board Telemetry Processing

On March 23, 1978, VO-2 developed a major leak in one of the yaw axis control gas jets. Attempts to clear the leak were unsuccessful and, within a 12-h period, over 6 months supply of gas was lost. To reduce gas consumption, thereby making it possible to save the spacecraft for its final science observations during June and late July, the spacecraft was placed in the roll drift mode of operation.

During roll drift, various stimuli such as solar pressure and gravity gradients during periapsis gradually build up the roll rate to a point where attitude control gas is used at high rates. As a result, periodic roll maintenance is required to slow the rate down. Roll maintenance consists of going to roll inertial

mode of control to stabilize the roll axis with a probable recurrence of another roll valve leak. Because round trip signal times are in excess of 30-min, it is possible to have a leak occur during roll drift maintenance, depleting the remaining gas supply prior to discovery and corrective action by ground command.

To solve this problem, the Viking Orbiter flight software in the Computer Command Subsystem (CCS) was updated to provide for downlink telemetry monitoring. During roll maintenance on May 8 and June 1 the Orbiter 2 spacecraft Computer Command Subsystem successfully issued a series of commands to the Attitude Control Subsystem as a result of the onboard telemetry monitoring. Both the May 8 and June 1 operations were successful on the first try. Backup procedures were available to clear the valve by a series of ground commands if necessary, but they were not needed. The spacecraft automatically terminated roll drift, sampled the data, checked for leaks and returned the spacecraft from roll inertial to roll drift mode.

These operations were the first JPL onboard processing of telemetry data which resulted in spacecraft commanding and as such they represent a milestone in spacecraft operations. Until this time all responses to unusual circumstances have been specified prior to launch and implemented with either subsystem internal design or hardwired interrupts from the subsystem to the CCS. Using telemetry monitoring, a large number of parameters or functions of sets of parameters can be used to control the spacecraft autonomously.

C. Viking Continuation Mission

The primary missions of Viking were terminated on November 15, 1976, at the time of solar conjunction because of the imminent loss of the communication links between Mars and Earth. By December 15, 1976, communication was reestablished and the "Extended Mission" commenced.

The Viking Extended Mission terminated on May 31, 1978. Since both Orbiters and Landers were still operational, funding was approved for a continuation of the Viking mission for another nine months at a reduced level and with a much smaller flight team. The Viking Continuation Mission (VCM) project will be managed by JPL.

The objectives of the Viking Continuation Mission are essentially the same as those of Extended Mission, but with a shift of emphasis more toward Orbiters than Landers. The major goal is to complete one full Mars year of observation of the planet, including filling in the season that was obscured by solar occultation at the end of the Primary Mission, and to make a start on determining the extent to which weather conditions repeat themselves in succeeding years.

During the Continuation Mission both Landers will be in the automatic mission mode, performing repetitive observations. Data will be acquired from imaging, meteorology and seismology experiments. The Lander loaded science missions will terminate on or before December 1, 1978, but at least one Lander will be left in a state such that its data can be read out over the direct link occasionally, and range measurements to it can continue to be made for at least another year.

All three Orbiter science experiments will be continued, but their observational sequences will be simpler and more repetitious than previously. After December 1, 1978, their operation will either be terminated or still further reduced. The operational aspects of the Viking Mission are currently planned to terminate on February 28, 1979. Figure 1 shows the Viking Continuation Mission Profile strategy.

D. Radio Science

Radio science activities and experimentation continued during May and June. These activities include near-simultaneous Lander/Orbiter ranging, VO-1 and -2 Earth occultation coverage, and the Gravity Field Experiment.

During the Viking Continuation Mission radio science investigations, including the occultation experiment, the local gravity anomaly experiment, and Lander ranging, will continue, and in December, January and February, which is the next solar conjunction period, the solar corona and relativity experiments will be repeated.

II. Network Support

Table 1 shows the DSN tracking support for January through June 1978. During the May and June period over 75% of the DSN support was from the 64-m network. This is primarily due to the Earth-Mars distance, which requires the additional 8-dB antenna gain to obtain the Viking high-rate telemetry data. Noticeable also during the May and June period is the reduction in total DSN tracking support, which follows the basic guidelines of a reduced level of operations during the Continuation Mission.

Table 2 gives the total number of commands transmitted by the DSN for the Viking Project during January through June 1978. The reduction in number of commands transmitted in May and June again reflects the reduction in Viking operations for the Continuation Mission.

Figure 2 shows the performance of the DSN delivery of the telemetry Intermediate Data Record (IDR) during the Viking Extended Mission. The IDR is a magnetic tape of digital telemetry data produced by the DSN. As a goal, within exist-

ing time constraints, the DSN attempts to provide 100% of the data recorded at the Deep Space Station on the Digital Original Data Record (DODR) magnetic tape. IDR's are required to be delivered within 24-h following the end of a stations pass.

During the Viking Extended Mission the data content of the IDR exceeded 99.5%. Average delivery time was between 4 to 10-h until February 1978, at which time the IDR delivery time steadily increased but never exceeded the committed 24-h delivery requirement. Several reasons contribute to the increase in delivery times. Primarily the change was due to the increased work load in the Network Data Processing Area (NDPA) brought on by the Voyager and Pioneer Venus Project priorities and the new radio metric IDR requirements. Another major contributing factor was the change in the maintenance and operations contract changeover, resulting in the loss of qualified personnel and the need to train their replacements.

Table 1. VEM Tracking Support, 1978

DSS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
					Tracks/Hours							
11	8/72	–	19/167	–	18/164	1/1						
12	–	4/13	5/22	1/8	–	–						
14	40/319	25/218	37/272	47/365	25/231	34/242						
42	22/166	23/76	30/201	30/192	2/4	–						
43	57/294	14/207	15/68	27/163	40/281	46/346						
44	–	11/51	6/43	–	11/77	3/17						
61	10/88	38/243	25/281	15/159	2/26	–						
62	6/27	2/25	3/22	3/29	8/75	3/33						
63	13/101	21/181	30/293	42/440	26/206	41/343						
Total	156/1067	138/1014	170/1369	165/1356	132/1064	128/982						

Note: Numbers of tracks represent the summation of all Viking spacecraft tracked. Track times, in hours, represent scheduled station support.

Table 2. Number of commands transmitted in Viking extended mission during January through June 1978

DSS	Jan	Feb	Mar	Apr	May	Jun
11	1947	–	119	–	1628	6
12	–	1	1	374	–	–
14	4565	1079	1326	3032	2845	1214
42	1447	1305	261	1079	0	0
43	1593	1732	124	275	1326	1567
44	–	255	3	–	373	0
61	992	3548	1073	1503	0	0
62	1	1006	461	73	0	960
63	895	128	2597	4005	669	2451
Total	11440	9054	5965	10341	6841	3198

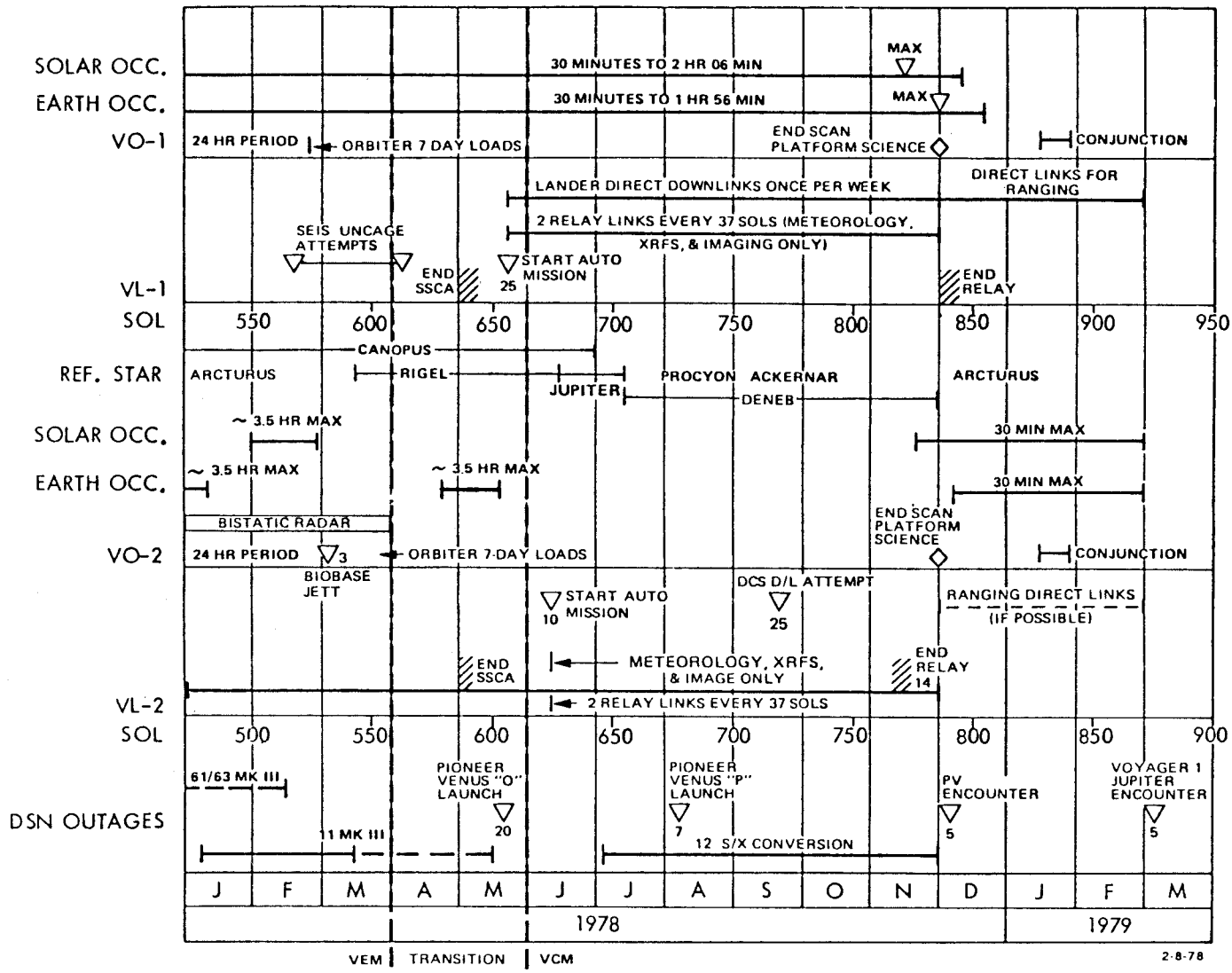

Fig. 1. Viking Continuation Mission profile strategy

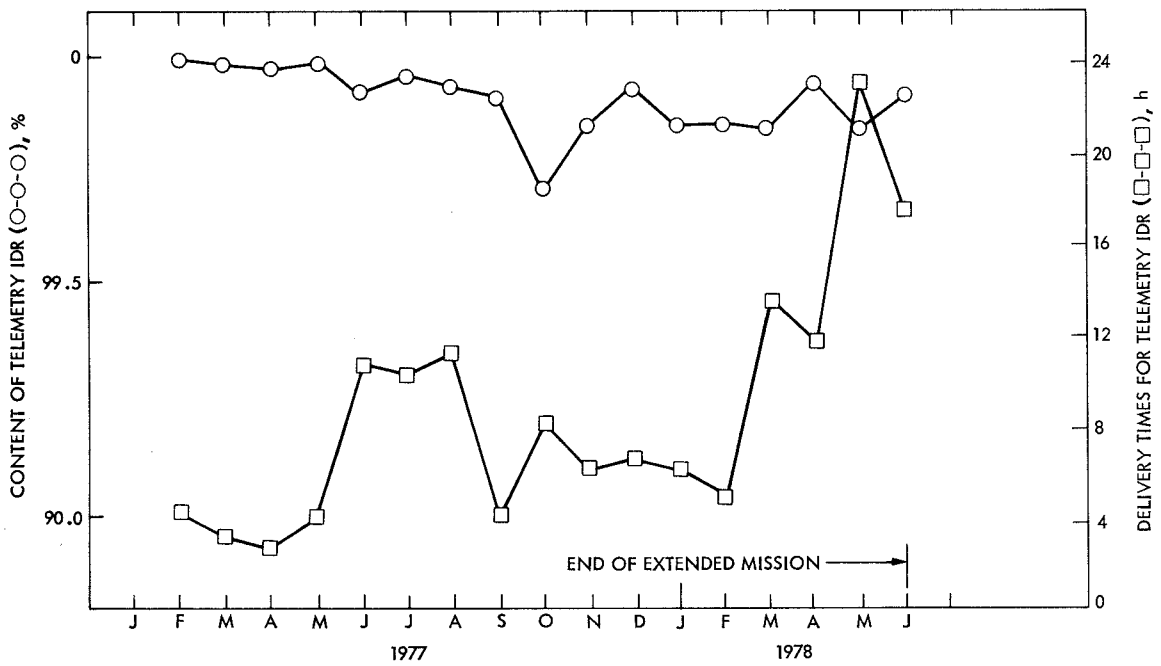

Fig. 2. Viking Extended Mission telemetry IDR performance