Viking Mission Support

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This article reflects the finalization of the Viking 1975 hardware configurations and the initial application of these configurations to detailed Viking 1975 strategies and associated operations procedures.

I. Introduction

The publication of the DSN Preparation Plan for Viking 1975 (614-20) on August 15, 1973, constitutes a major milestone in laying the foundation of budgeted hardware, software, and schedules, upon which the detailed operations planning may be based. Work is now in progress in the various working groups supported by DSN Operations in the Viking Flight Team Working Organization, to formulate strategies for use by the mission planners. These mutually agreed-on strategies then lead to the generation of supporting procedures by each of the groups concerned. This procedure generation in the DSN case is slightly different from that of the other groups, in that DSN procedures exist, many of which can be utilized as is, many more need to be modified for Viking 1975 use, and some others, unique to Viking 1975, need to be generated to fill the Viking 1975 requirements. With the publication of the basic system configurations in the DSN Preparation Plan, work has now started on the production of various configurations (and backups) for each mission phase, and the reviewing, modification, and generation of associated operations procedures for inclusion in the Network Operations Plan.

II. Documentation

The DSN Preparation Plan (614-20) was released on August 15, 1973. The next issue of the Network Operations Plan (614-21) has been delayed to November 1, 1975, in order to reflect the systems capabilities and configurations defined in the Preparation Plan.

III. Viking Configurations

Practically all of the implementation/operational conflicts on the Viking 1975 configurations have now been resolved.

The requirement for dual uplink carriers (single-station) has been deleted and the proposed 100-kW transmitter installation at DSSs 43 and 62 has now been postponed until after the Viking 1975 mission. These stations will have the currently operational 20-kW transmitters, and dual uplinks will be provided by dual station operation.

Some major long-lead-time items on the implementation schedules, such as station block updates during the Viking 1975 orbital operations phase, appear to be an unacceptable operational constraint, and several of these items, though they do not have any impact at this time, will require discussion and resolution in the near future.

IV. Voltage-Controlled Oscillators

Stations are being supplied with Quad voltage-controlled oscillators (VCOs) crystallized for channels 9, 13, 16, and 20. Channels 9 and 20 are for Orbiters A and B, respectively, while channel 16 is the spare Orbiter frequency. Channel 13 will be used for Lander A, Lander B, and the spare.

During certain mission periods, doppler conditions will cause frequency excursions to the extent that VCOs will be taken to the extreme end of their operating range; therefore, it has been decided that offset VCOs are required in the prime 26-m network Block III receivers and exciters. The 64-m station Block IV receivers and exciters do not require crystals.

V. Viking Lander Acquisition and Command Strategy

One of the Viking 1975 strategies which has involved DSN participation is the subsequence to be used to acquire the Viking Lander (VL) S-band carrier and command detector. A nonstandard strategy is required because the VLs have severe power limitations which result in nominal maximum spacecraft transmitter and receiver programmed *on* times of approximately 70 min and 3 h, respectively, each 24.6-h (Mars day) period. This, coupled with a predicted round trip light time (RTLT) of approximately 40 min, poses some problems when it is realized that the spacecraft receiver best-lock frequency uncertainty may be extremely large due to exceptionally large temperature variations. As the spacecraft transmitter will be turned off each day, there will be no telemetry data to monitor these temperature variations immediately prior to the acquisition, and the transmitter *on* time is so short that to wait and acquire in a one-way tracking mode would use 20 min of transmitter *on* time (½ RTLT). Even though telemetry is then available, the spacecraft temperature would not be static, due to the transmitter turn-on, so an uplink acquisition sweep would still be necessary to acquire (nominally 10 min at expected uplink power levels). If we then waited the 40-min RTLT to observe the S-band acquisition via telemetry before turning on command modulation to load the commands, we would possibly see the acquisition and immediately drop lock on the ground receiver as we would have come to the end of that day's spacecraft transmitter *on* period; i.e.,

20 min = ½ RTLT = VL transmitter *on* to DSS lock

10 min = uplink sweep

<u>40 min</u> = RTLT = end of sweep to DSS two-way lock

= 70 min = total VL transmitter *on* time

We would thus have achieved two-way lock and confirmed this only seconds before losing it for another 24-h period. We would then be in a one-way (uplink) tracking mode capable of acquiring command detector lock and transmitting commands to the VL, but without any downlink (telemetry) to confirm command lock or command receipt. When it is realized that some of these are commands to turn the VL receiver and transmitter *off* and *on*, it becomes immediately obvious that this rather conservative subsequence, which would be the type used with a spacecraft having large variations in best-lock frequency, is completely unacceptable for use with the VL spacecraft.

A group of Martin Marietta Aerospace Lander Flight Team personnel was given the task of generating a series of VL acquisition strategies for consideration. Seventeen tentative strategies were produced and critiqued by DSN Operations personnel, and the field was narrowed down to the three shown in Figs. 1, 2, and 3.

It should be borne in mind that the VL will be subjected to internally produced variations in temperature (and thus frequency) due to the heat dissipated by the various experiments (instruments) whose work load will vary widely from day to day, superimposed on the day/night variations on the planet surface.

A further point is that the heavy electrical power consumption of the transmitter and traveling wave tube amplifier (TWTA) occurring with transmitter switch *on*, is also increased as the VL high-gain antenna is rotated at this time to boresight on Earth.

VI. Strategy Analysis

A. Strategy 1A

Strategy 1A (Fig. 1) shows the VL transmitter and receiver programmed *on*, together with the ground transmitter tuning scheduled to start 20 min prior to VL turn-on. This enables the 40-min full-acquisition uplink sweep to be monitored via telemetry on the downlink.

The VL receiver is then programmed *off* at the end of the 40-min sweep and programmed *on* again.

After a 10-min possible retune of the spacecraft receiver static phase error (SPE) to zero or to reduce it to within acceptable limits, the command modulation is then turned on and command transmission started.

This strategy allows full monitoring of the S-band acquisition but does not provide monitoring of command acquisition or receipt, and does not allow for a reacquisition or retransmission of commands.

Strategy 1A, or a modified version with split transmitter times, may be used for the initial VL acquisition only.

B. Strategy 2A

Strategy 2A (Fig. 2) is similar to 1A except that the transmitter *on* time is programmed to occur after two-way lock.

This strategy would be used if experience proves that the VL spacecraft SPE tolerance during commanding is relatively small, and the best-lock frequency uncertainties are large, requiring large full-scale tuning sweeps, with the possible requirement for retuning to zero SPE. S-band acquisition is confirmed, command lock is confirmed, and the first 20 min of the nominal 30-min command load is confirmed, with the possibility of blind retransmission of commands if required.

C. Strategy 3B

The main difference in Strategy 3B (Fig. 3) is that the S-band acquisition, command acquisition, and command transmission are all carried out "in the blind."

Assuming reasonable probability of realistic tolerances on acceptable SPE and reasonably precise best-lock frequency predicts (short sweeps—no retuning), this strategy would be the prime choice. This gives confirmation of S-band acquisition and command receipt. It also gives time for a second complete command retransmission and confirmation with the ability to command an extension of the transmitter and receiver *on* times.

Also, if necessary, the VL could be acquired using the Block IV receiver–exciter which, although deleting the X-band from the Viking Orbiter support, would enable the tuning rates to be increased, thereby reducing the tuning sweeps by approximately half.

The strategies above will be checked out during the spacecraft/DSN RF compatibility tests at CTA 21 during June, July, and August, 1974.

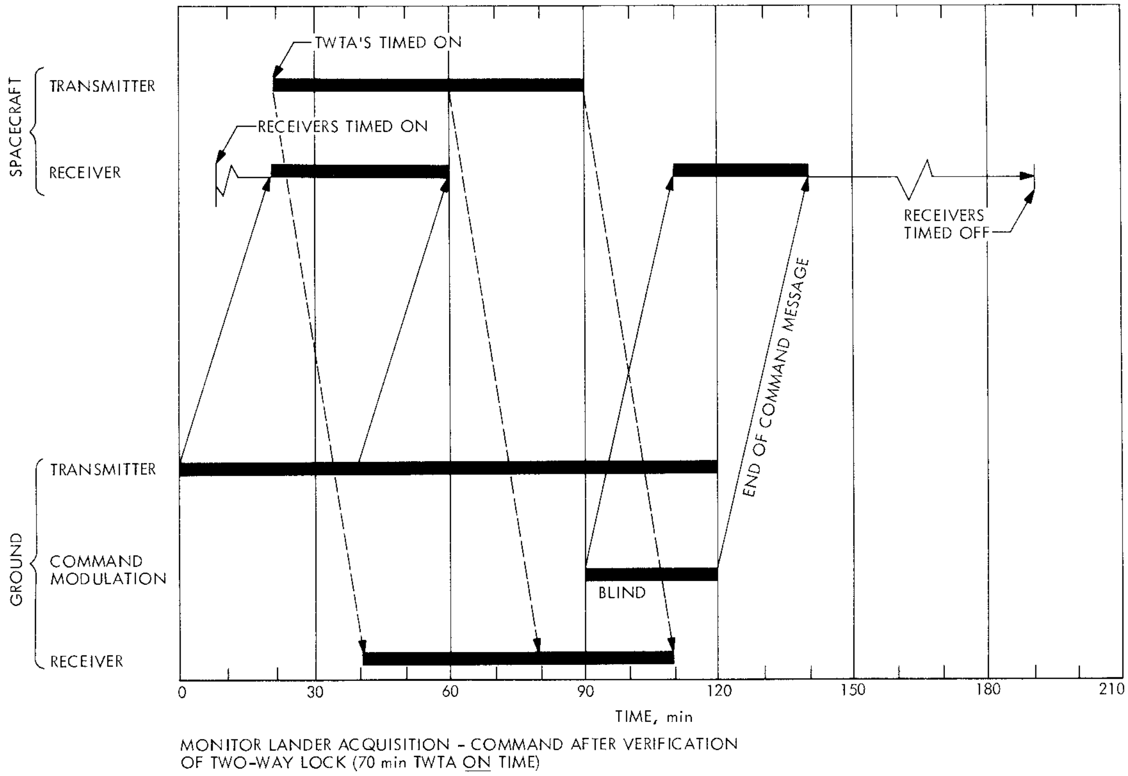

Fig. 1. Lander Command Strategy 1A

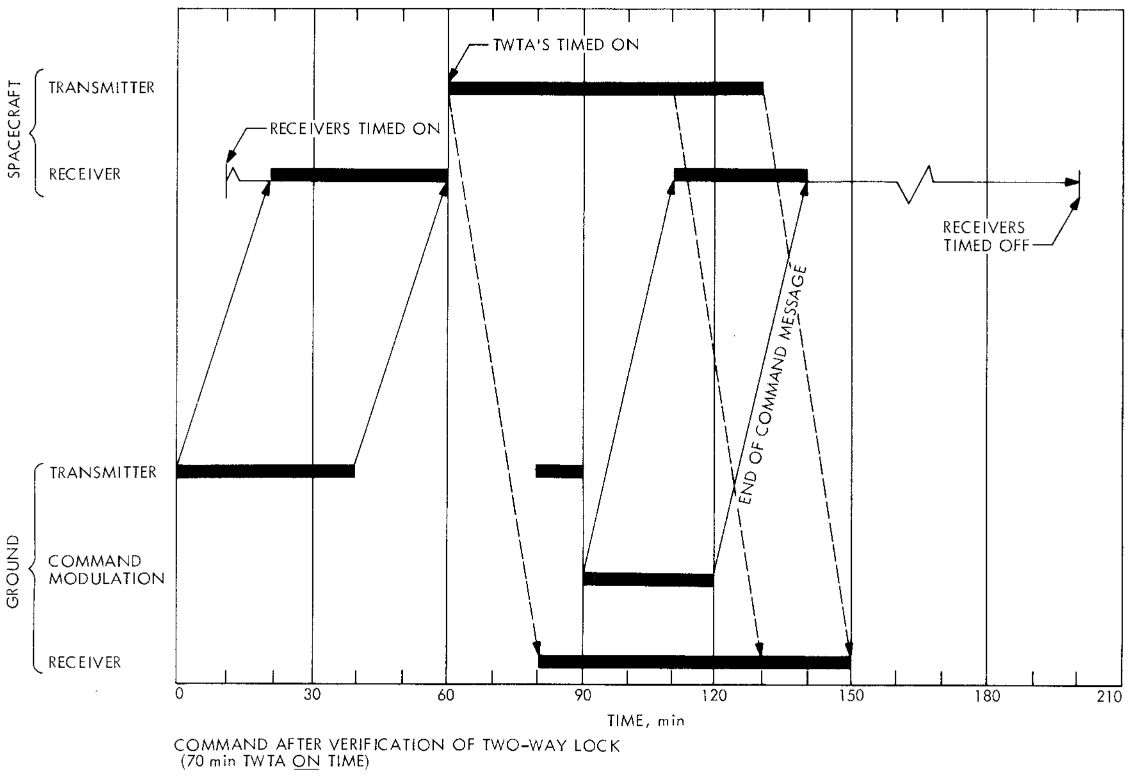

Fig. 2. Lander Command Strategy 2A

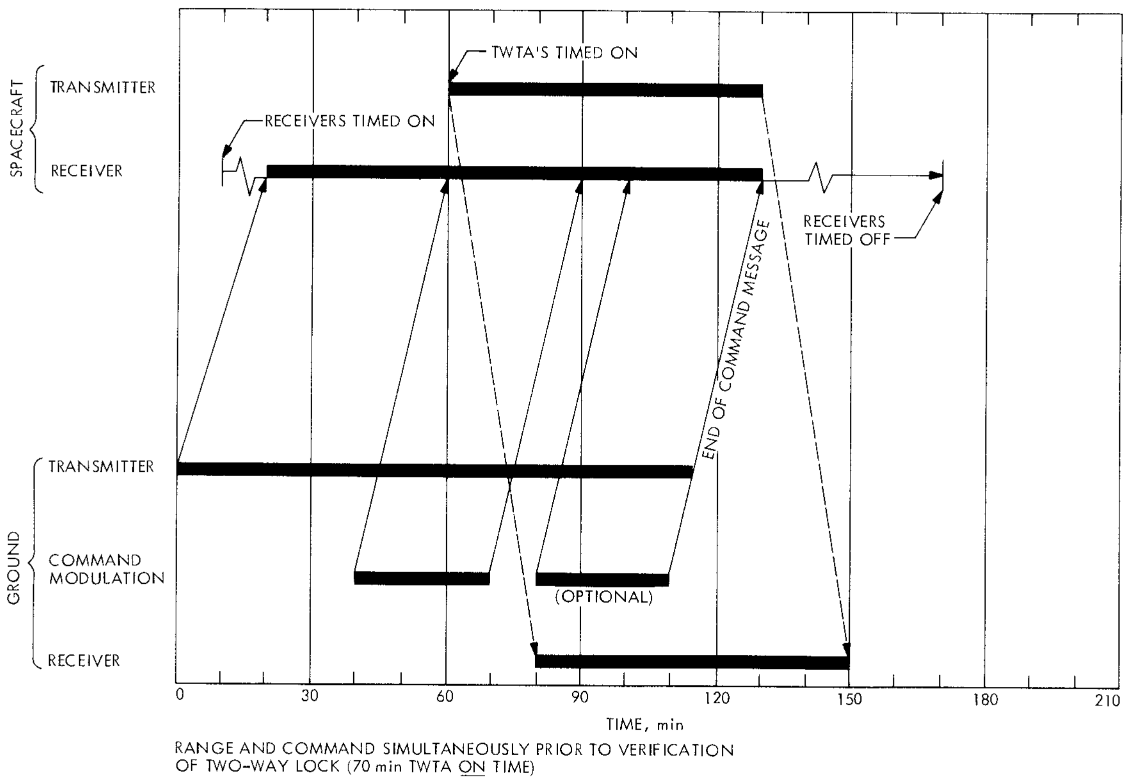

Fig. 3. Lander Command Strategy 3B