# Use of "Load and Go" Countdowns by the DSN Deep Space Stations

J. T. Hatch
Network Operations Section

*The Level-4 Prepass Readiness Test (PRT) (the "load and go" countdown) provides an effective and low risk method of improving Network productivity. A carefully controlled trial period preceded the full-scale application of the Level-4 PRT to Pioneer, Helios and Viking cruise tracking operations. Use of this "load and go" concept to count down a station brings about a substantial increase in the proportion of total station hours devoted to spacecraft tracking.*

## I. Introduction

Time is scheduled at a Deep Space Station (DSS) prior to direct support of spacecraft tracking operations so as to prepare the station to meet all requirements of a forthcoming pass. These prepass preparations are termed Prepass Readiness Tests (PRTs) and consist of establishing and testing the specified configuration. Levels of support are used to define the extent to which equipment and systems are to be tested to support the scheduled activities. The four basic levels of support are summarized in Table 1 in terms of capabilities provided and the amount of time needed to perform a PRT for the level of support required.

Increasing the number of station hours devoted to actual tracking operations enhances the productivity of the Network. Since reducing the amount of time required for PRTs has the effect of increasing the total hours available for tracking, use of the Level-4 PRT offers a substantial potential for improving Network productivity. The flight projects benefit from any increase in the amount of tracking support they receive.

## II. Characteristics

From the standpoint of Network productivity, the most significant characteristic of the "load and go" countdown is the short length of time required to complete it. Other characteristics that differ from those of the longer countdowns are described below.

### A. Calibration Data

No equipment calibrations are performed. Rather, use is made of the latest previous calibration data available.

### B. Software

Telemetry and Command Processor (TCP), Antenna Pointing Subsystem (APS) and Digital Instrumentation

Subsystem (DIS) software programs are not exercised as required for the other levels of support. After configuring the equipment, the programs are merely loaded into the computers and initialized to commence running at the beginning of the pass. However, prior to acquisition, two test commands are sent from the TCP to a dummy load to validate the on-site command system interface.

### C. Data Validation

No telemetry, command, tracking, or monitor data transfer tests are run between the station and the Network Operations Control Center (NOCC). Instead, the first 30 minutes of each pass are used for this purpose and to validate the data. The data obtained during this period are provided to the Project.

### D. Discrepancy Reports

Deep Space Network Discrepancy Reports (DRs) are handled differently in those cases where equipment calibrations are out of limits, equipment failures and procedural errors occur during the first 30 min of a pass, and the acquisition of signal (AOS) from a spacecraft is not accomplished on time. On these types of problems, DRs are closed out on the basis of having resulted from a load and go countdown, with its attendant and recognized slightly higher risk. Throughout the Pioneer–Helios trial period that is described in this article, DRs were waived on problems encountered during the 30-min period immediately following the scheduled AOS time.

## III. Implementation

Level-4 PRTs were implemented on a Network-wide basis in two phases. The first phase involved Pioneer and Helios projects. It was preceded by a successfully completed two-week trial period (November 10–23, 1975), following which the countdowns were scheduled routinely, as negotiated by the Network Operations Representative (NOR) for each Project. The second phase trial period was successfully conducted for the Viking Project between January 5 and January 18, 1976, and routine scheduling of the countdowns for cruise phase support, as negotiated with the Project by the Viking NOR, was commenced on January 19, 1976.

### A. Pioneer/Helios Trial Period

As depicted by Table 2, 52 load and go countdowns (27 for Pioneer and 25 for Helios) were accomplished during the period. An analysis of DSS performance during this period was made to determine if any significant conclusions could be drawn from the statistics relative to ability of the stations to complete the countdowns on time, problems encountered, and the incidence of DRs initiated during the trial period as compared to the preceding four-week period. The following significant facts emerged from the analysis of DSS performance with respect to countdown completion times and ability to achieve AOS on time (Table 3):

(1) Ten of the 54 total AOSs were achieved exactly on time.

(2) Of the remaining trial tracks, early AOSs outnumbered the late ones, making possible the realization of some 26 min additional tracking time.

During the trial period, six problems were encountered that affected support and on which DRs would have been initiated under normal circumstances. Two of these involved equipment malfunctions and four were related to procedural or operator problems. The problems resulted in late AOSs. However, DRs were waived for this period, as mentioned above. Analysis of figures presented in Table 4 reveals the following:

(1) The number of DRs initiated during the trial period is consistent with the number initiated in each of the preceding two-week periods.

(2) Assuming DRs had been initiated on the six problems mentioned above, the total number (21) for the trial period then would have been the same as that for the October 13–26 period and not too far out of line with the number (13) for the period October 27–November 9.

Both Projects were well satisfied with the DSS performance during the trial period. However, it was also recognized that, with Viking being allocated the most support and using higher level (longer) countdowns than Pioneer and Helios, it was necessary to adopt the load and go concept for Viking in order for Pioneer and Helios Projects to receive any appreciable increase in tracking hours. Because the Pioneer/Helios view periods preceded and overlapped Viking's, Pioneer and Helios tracks could be extended by the amount of time "saved" by the shorter Viking countdowns (Fig. 1).

### B. Viking Trial Period

Success with the Pioneer–Helios Level-4 PRT trial period facilitated obtaining agreement to conduct a similar program for Viking during the period January 5–18, 1976. A slight increase in the occurrence of DRs was noted; the increase was attributed to the fact that a policy

had been initiated on January 1 requiring that DRs be initiated on all problems. However, the incidence of DRs soon returned to the same level as existed before the advent of a load and go countdown. The Viking trial period was considered a success, and scheduling of the Level-4 PRT was implemented immediately for all routine Viking cruise passes.

### C. Communication Circuit Activation

Philosophy regarding communication circuit activation requirements evolved through the following different concepts, commencing with the Pioneer–Helios trial period:

(1) Initially, the circuit activation times remained unchanged, and circuits were available for use one hour before AOS. This presented problems for those stations that were not staffed continually, and particularly when a load and go countdown was scheduled to commence at the very beginning of the arrival of a new shift (following a station closed period). In this situation, the circuits were scheduled to be activated 30 min before the station was to be staffed, which disrupted accomplishment of the normal DSN Ground Communications Facility (GCF) and NASA Communications (NASCOM) line checkout procedures.

(2) A Level-4 PRT concept for communications circuit activation was implemented on January 1, 1976. In this mode of operation the GCF/NASCOM line checkout procedures were waived and the circuits turned over to the DSS and Network Operations Control Team (NOCT) for use immediately upon activation (30 min prior to AOS).

(3) On April 6, 1976, the waiver on use of GCF/NASCOM procedures was withdrawn and the requirement to perform the necessary line checks on a compressed schedule was instituted, with circuits being turned over to the DSS and NOCT for use at AOS minus 15 min. This remains the current mode of operation; but problems have been caused for the DSSs and NOCT when extended line checkout activities have made the circuits unavailable until AOS time or even later.

Experience has shown that the load and go concept for circuit activation resulted in fewer problems for the DSSs and NOCT. Therefore, a return to that mode of operation is anticipated in the near future, on the assumption that it will be acceptable to both GCF and NASCOM management.

## IV. Productivity Assessment

A study was conducted to determine the amount of additional tracking time that was made available to the Flight Projects through use of the Level-4 PRT during the period November 23, 1975–May 10, 1976. Table 5 provides a breakdown, by Flight Project, of the number of standard and short countdowns utilized, plus the amount of tracking time associated with each type of countdown. Since a Level-4 PRT makes available an additional 1.5 hours of tracking time, it is calculated (1276 passes $\times$ 1.5 hours) that 1914 additional tracking hours actually were realized. For the load and go passes only, this represents a 22% increase in tracking time; the increase for all passes ("load and go" and "standard" countdowns combined) is a substantial 17%.

## V. Conclusion

The Level-4 PRT was used by the DSN stations in support of approximately 75% of all spacecraft tracking passes during the period November 23, 1975–June 1, 1976. A new computer-aided countdown (CAC), which was developed by Madrid Complex personnel, has been implemented for Viking planetary operations. Although longer than a Level-4 PRT, the CAC is considerably shorter (2 to 5 hours) than the Level-1 PRT that otherwise would have to be used for the critical Viking support. Use of the Level-4 PRT for Pioneer and Helios continues, and a return to more extensive use of the load and go countdown for all Flight Projects is anticipated on November 15, 1976, when the Viking prime mission ends. Since all three Flight Projects then will be in an extended mission mode, it seems reasonable to assume that the additional tracking time resulting from use of the Level-4 PRT will exceed the 17% increase that already has been realized over a period of several months duration.

**Table 1. PRT levels of support**

| PRT Level | PRT Hours[a] | Type of requirement | Capability provided |
|---|---|---|---|
| 1 | 8.0 | Critical redundant support | Highest possible degree of reliability and accuracy in system calibrations including on-line redundant system |
| 2 | 5.0 | Critical nonredundant support | Same as Level-1 except redundant systems are on 10-min standby and tested to Level-3 requirements |
| 3 | 2.0 | Normal support | Lower data quality tolerances than for Levels 1 and 2 but exceeding those of Level-4. Redundant equipment on 30-min standby and tested to Level-4 requirements |
| 4 | 0.5 | Minimum (load and go) support | Satisfies basic requirement for housekeeping data from cruising spacecraft, with telemetry predicted SNR greater than 3dB. First data point understood to be unimportant |

[a]Additional time (as much as 1 hr) may be required when items such as polarizers, high-power transmitters, and ranging calibrations are required.

**Table 2. Pioneer/Helios level-4 PRT trial period (Nov. 10–23, 1975)**

| DSS | Planned | | Accomplished | |
|---|---|---|---|---|
| | Pioneer | Helios | Pioneer | Helios |
| 11 | 4 | 4 | 4 | 4 |
| 12 | 0 | 0 | 1 | 1 |
| 14 | | 1 | | 1 |
| 42 | 4 | 8 | 4 | 8 |
| 43 | 7 | 1 | 7 | 1 |
| 44 | 2 | | 2 | |
| 61 | | 10 | | 10 |
| 62 | | | | |
| 63 | 9 | | 9 | |
| Totals | 26 | 24 | 27 | 25 |
| | 50 | | 52 | |

**Table 3. DSS AOS record for Pioneer/Helios level-4 PRT trial period**

| AOS | Number of times | | Time, min | |
|---|---|---|---|---|
| | Pioneer | Helios | Average | Total |
| Early | 14 | 10 | 6.5 | 156 |
| Late | 7 | 11 | 7.2 | 130 |
| Additional tracking time realized | | | | 26 |

**Table 4. DR comparisons**

| Period | Number of DR'S | | |
|---|---|---|---|
| | Pioneer | Helios | Total |
| Oct. 13–26 | 14 | 7 | 21 |
| Oct. 27–Nov. 9 | 10 | 3 | 13 |
| Nov. 10–23[a] | 9 | 6 | 15 |

[a]Load and go countdown trial period.

**Table 5. DSS countdown and tracking time comparisons (Nov. 23, 1975–May 10, 1976)**

| Project | Standard countdowns | | Load and go countdowns | |
|---|---|---|---|---|
| | Number | Tracking hours | Number | Tracking hours |
| Pioneer | 126 | 810.2 | 411 | 2107.2 |
| Helios | 119 | 649.7 | 451 | 2927.8 |
| Viking | 156 | 1475.7 | 414 | 3479.2 |
| Totals | 401 | 2935.6 | 1276 | 8514.2 |

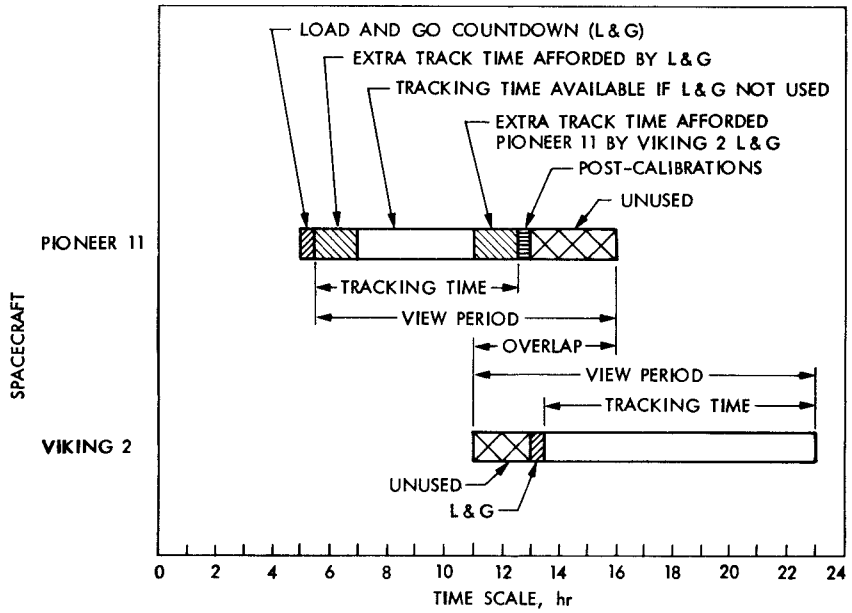


Fig. 1. Example of additional Pioneer 11 tracking time afforded by Level-4 PRT (load and go)