Viking Mission Support

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As part of the activity for preparing the Deep Space Network for support of the Viking mission, it is planned to conduct a series of tests in which multiple data streams are passed between the Deep Space Stations (DSSs) and the Viking Mission Control and Computing Center (VMCCC).

The data streams simulate real data types and data rates and are handled by all the hardware and software in the DSS and VMCCC in exactly the same way as the real data. The performance of the DSN and VMCCC in generating, handling, and processing these data is a measure of the readiness of the entire Ground Data System to enter live mission support.

The first series of these tests has recently been run between the Compatibility Test Area (CTA 21) and the VMCCC and the results are reported in this article.

I. DSN-VMCCC System Integration Tests

A. Interfaces

Organizationally the Viking Project is structured into six systems as follows:

(1) Viking Orbiter System (VOS).

(2) Viking Lander System (VLS).

(3) Launch and Flight Operations System (LFOS).

(4) Launch Vehicle System (LVS).

(5) Viking Mission Control and Computing Center System (VMCCCS).

(6) Tracking and Data System (TDS).

It is a matter of Project policy that the interfaces between adjacent systems shall be formally documented and tested as a prerequisite to any Project prelaunch testing. This policy is given in Ref. 1.

In the case of the interface between the VMCCC and the Deep Space Network (DSN) portion of the TDS, Ref. 2 formally describes and controls the VMCCC to DSN interface for Viking. To accomplish this purpose, it is necessary to describe (1) the media by which the information is transferred between the systems, (2) the intrasystem constraints, which include the functional relationship between each portion of a particular system in the DSN and in the MCCC, and (3) the data formats which will provide the framework for data interchange.

B. Testing

The plan by which these interfaces will be tested is given in Ref. 3. These series of tests are called System Integration Tests (SITs); separate SITs are planned between the VMCCC and each tracking station or test facility of the DSN involved in Viking support. The SITs have been carefully fitted into the overall Ground Data System test schedule for Viking and include CTA 21 and the Spaceflight Tracking and Data Network Merritt Island Station (STDN MILA) as well as all the Deep Space Stations (DSSs).

C. Responsibilities

Overall responsibility for conduct of VMCCCS/DSN system integration testing is assigned to the VMCCC Data System Project Engineer (DSPE), who acts as the Test Conductor. The DSN Network Operations Project Engineer (NOPE) will act as coordinator for the DSN during the SITs. In turn, the NOPE is supported by the Network Control System (NCS) and the Network Analysis Group.

II. CTA 21 System Integration Tests

The first of the scheduled SITs was carried out with CTA 21 over the period April 15 through June 1, 1974. The Viking configuration for CTA 21 used for these tests is given in Figs. 1 and 2 for telemetry and command. A summary of the tests performed and the results compiled by the Viking NOPE are given below:

The tests were conducted in four phases:

(1) Test the DSN/VMCCCS interface for Lander telemetry.

(2) Test the DSN/VMCCCS interface for Orbiter telemetry.

(3) Test the DSN/VMCCCS interface for Viking Lander/Viking Orbiter (VL/VO) command.

(4) Test all functional interfaces simultaneously with maximum loading.

1. SIT 1, April 16, 1974: Lander telemetry. The objectives of SIT 1 were to verify the VMCCC/DSN telemetry interface for specified Lander telemetry modes and data rates. The specified data rates were the Lander direct telemetry data at 8-⅓ bps and engineering at 250, 500, and 1000 bps for science data. Forty-five science format changes were planned; of these, 37 were accomplished prior to the termination of the test. The prime objectives were met; however, a bit stream anomaly in the science data was noted. This anomaly appeared to be a telemetry and command processor (TCP) software problem.

2. SIT 2, April 19, 1974: Lander telemetry. The objectives of SIT 2 were to verify the VMCCC/DSN telemetry interface for three Lander telemetry data streams. The maximum interface loadings for a Lander spacecraft (S/C) are 8-⅓ bps engineering, 1 kbps science, and playback of the Lander data from track-8 of the Orbiter at 16 kbps. With this test, all of the Lander telemetry format verification was completed on the 1-kbps direct science data. The 8-⅓ bps engineering data were processed without problems; again, as in SIT 1, a bit stream anomaly was observed within the 1-kbps science data; however, this anomaly did not prevent the data from being processed.

High-rate Orbiter data were processed at 4 kbps. Timing problems between the simulation center (SIMCEN) 360/75 and the GCF interface precluded effective testing at bit rates in excess of 4 kbps.

Although the test included the independent Lander telemetry testing, maximum loading at 16 kbps playback from the VO was not accomplished. This problem was attributed to the simulation/Ground Communications Facility (SIM/GCF) interface, and the Orbiter telemetry testing was deferred and replaced with the command testing phase.

3. SIT 5, April 23, 1974: Lander command. The test objectives of SIT 5 were to verify the VMCCC/DSN command interfaces for Lander commanding in both the automatic and manual modes. The TCP at CTA-21 was configured to verify that commands could be processed in the standard configuration without alarms or aborts and that, in a non standard configuration, all warnings, alarms, and aborts occurred when the applicable conditions were established.

This test was successful, despite an early termination when the 360/75 being used for testing had to be released for real-time flight support. In all cases the command software performed properly. Operating personnel, however, were not fully aware of the idiosyncrasies of the new command software redesign because of lack of adequate training with this software.

4. SIT 6, April 26, 1974: Orbiter command. The objectives of SIT 6 for Orbiter commanding were identical to those of SIT 5 for the Lander. The objectives were met and the test sequence of events (SOE) was completed.

5. SIT 7, May 1, 1974: Dual Lander/Orbiter command. Simultaneous dual spacecraft commanding was the objective of SIT 7; this objective was not met.

Although a standard DSS configuration provides that only a single spacecraft be commanded at any specific time, CTA 21 must have dual command capability to satisfactorily conduct compatibility testing. Because CTA 21's second exciter (Block IV) had not been fully implemented, hardware and software workarounds to use the Block III exciter were attempted. These workarounds failed, and two exciters could not be emulated at CTA 21 for the completion of this test.

The remaining test time was utilized to complete the uncompleted sequence from SIT 5 (Lander command), and dual commanding was simulated by simultaneously conducting "in core" Orbiter commanding in the 360/75.

6. SIT 3, May 4, 1974: Orbiter telemetry. The objectives of SIT 3 were to verify the VMCCC/DSN telemetry interfaces for a single Viking Orbiter. These objectives were successful at all data rates except 16 kbps. The data rates processed were: engineering 8-⅓ and 33-⅓ bps, and science rates of 1, 2, 4 and 8 kbps in both coded and uncoded modes. The SIM 360/75/GCF timing problem, which had caused a delay of Orbiter telemetry testing, still existed, but the problem was less evident on the 50-kbps wideband data line (WBDL). The Mission Test and Computing Facility (MTCF) could not process the high-rate 8-kbps data for time periods greater than approximately 2 minutes, and CTA 21's simulation conversion assembly (SCA) could not lock on the 16-kbps data generated from SIMCEN. The Block IV receiver successfully processed engineering and science data during this test.

7. SIT 4, May 7, 1974: Orbiter telemetry. The SIT 4 objectives were to verify the VMCCC/DSN telemetry interface for maximum data rates and data streams (3) from one TCP. This loading configuration required both Orbiter data streams (33⅓ bps and 16 kbps) and a Lander science data stream at 1 kbps. This TCP loading objective was met, but the 16-kbps data stream could not be sustained by the Simulation Center for a period of time exceeding 1 to 2 minutes. This simulation constraint, which has been previously mentioned as a SIMCEN 360/75/GCF timing problem, was actually isolated to that interface during this test; only the 50-kbps WBDL was exercised during this test.

8. SIT 7 (Retest), May 10, 1974: Dual commanding. The objectives of this test were to configure CTA 21 so that it emulated two independent DSSs commanding two spacecraft simultaneously. Dual commanding was accomplished. An additional objective achieved during this test was the verification of the Lander telemetry interfaces in parallel with the command interfaces. Lander direct data at 8-⅓ and 250 bps were successfully processed.

The Lander science data bit stream anomaly, which had been previously observed in SIT 1 and SIT 2, was isolated during this test to the 360/75 SIMCEN/GCF interface.

9. SIT 9, May 14, 1974: Lander telemetry and command. The objective of SIT 9 was to exercise one fully loaded telemetry and command data (TCD) string with the combination of Lander telemetry and commanding simultaneously. The selected data rates were: 8-⅓ bps, 1 kbps and Orbiter track-8 Lander playback at 2, 4, 8, and 16 kbps; of these objectives, only the 8-⅓ bps, 1 kbps and command were processed. Difficulties in the DSN and VMCCC prevented other data rates from being processed within the allotted time. The test was considered to be only partially successful.

10. SIT 10, June 1, 1974: Two Orbiters and Lander telemetry. The objectives of SIT 10 were to verify that the VMCCC/DSN interfaces could handle the loading of multiple spacecraft telemetry data streams at maximum bit rates. These objectives were met: the VMCCC Simulation Center generated all of the high-speed telemetry data rates, while CTA 21's SCA generated the wideband data rates.

The Simulation Center high-speed data streams were 8-⅓ bps, 33-⅓ bps and 1 kbps. CTA 21 produced two 16-kbps wideband data streams by using the SCA in the stand-alone mode. These data rates were all successfully processed using the high-speed data lines and the 50-kbps wideband data line.

Problems were encountered on the 28.5-kbps WBDL portion of the test, but the problems appear to be a MTCF telemetry processor problem and not related to the SCA/TCD or GCF.

11. SIT 11, June 8, 1974: Two Orbiters and Lander telemetry and command. The test objectives were to verify that multiple spacecraft telemetry and command data streams could be processed simultaneously. These objectives were met. The TCPs were able to process data at maximum loading (one 8-⅓ bps and one 1 kbps Lander data stream plus two 33-⅓ bps and two 16 kbps Orbiter data streams) while commanding the Lander from one TCP and the Orbiter from the other TCP. The preceding configuration simulated all of the nominal data interfaces, including monitor data, that are expected during a planetary pass, or CTA 21's compatibility testing.

The second phase of this test was to simulate all of the nominal data interfaces that will be used during a planetary pass (full loading) from an overseas station. This configuration requires that the 28.5-kbps WBDL interfaces be exercised by processing two-Orbiter high-rate data streams simultaneously at 16 and 18 kbps. This configuration was also successful, but data processing at MTCF could not be sustained while using the 28.5-kbps WBDL. This 28.5-kbps WBDL problem appears to be a MTCF problem and not related to the TCD or GCF. All high-rate data streams were generated by CTA 21's SCA; as the SIMCEN/GCF interface problems have not yet been resolved.

The concluding tests in this series will be reported in a subsequent article.

References

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3. "Viking 75 Project Test and Integration Plan for the Viking Mission Control and Computing Center System, Viking Mission Control and Computing Center System to DSN Integration," Vol. IV, 619-6, May 1, 1974 (a JPL internal document).

4. "Network Operations Plan for Viking 75 Project," 614-21, Nov. 1, 1973 (a JPL internal document).

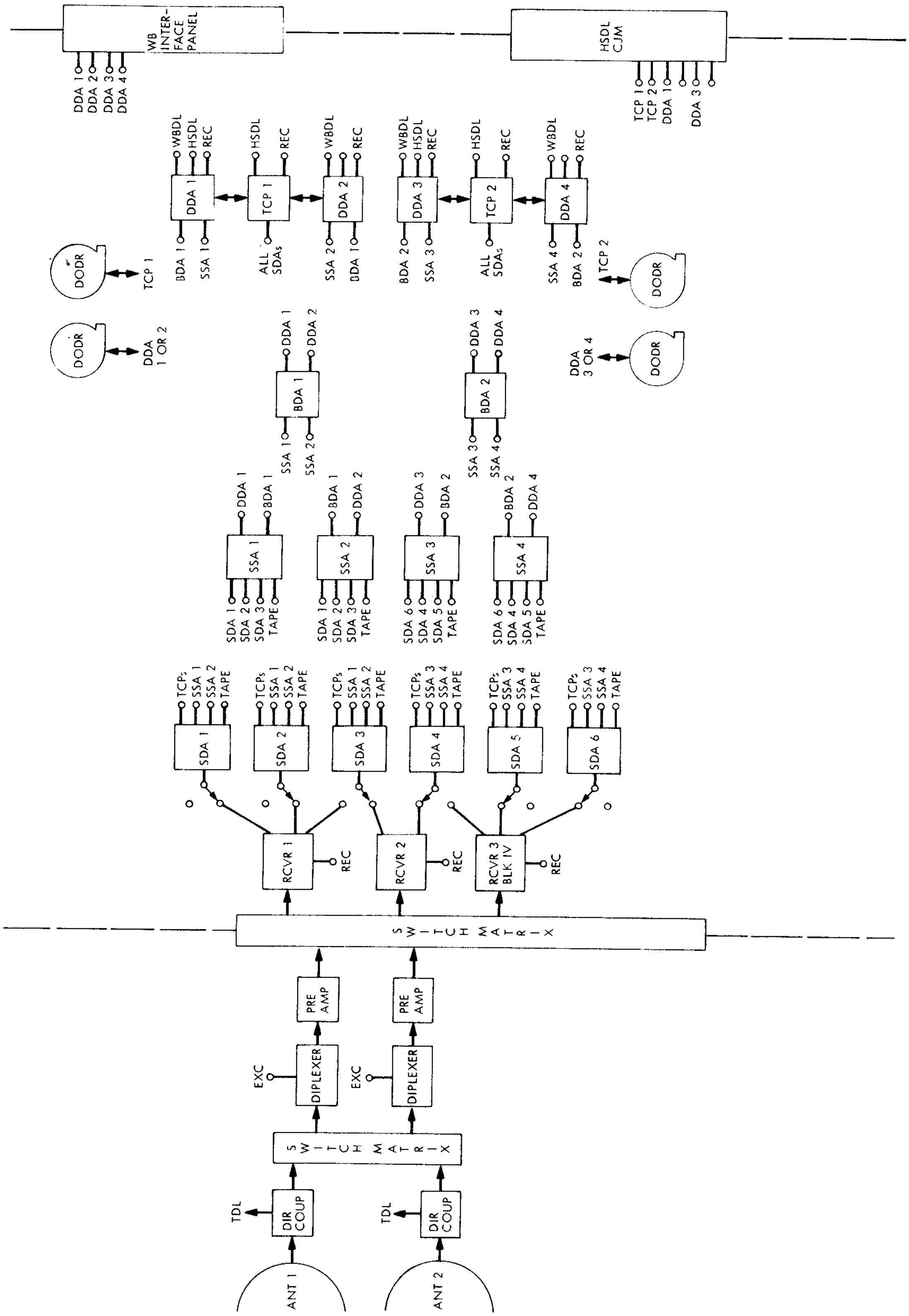

Fig. 1. CTA 21 Viking-75 telemetry configuration

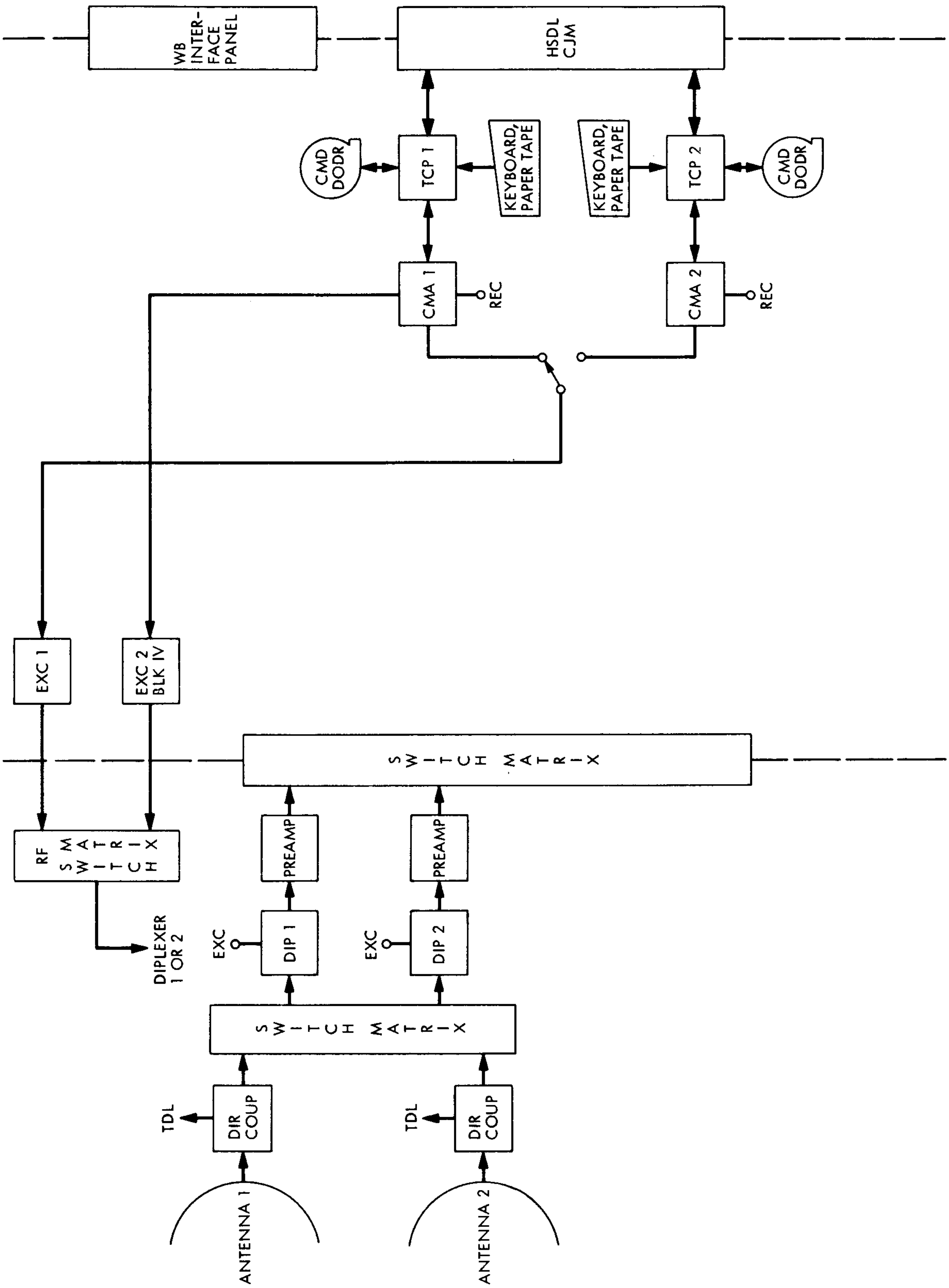

Fig. 2. CTA 21 Viking-75 command configuration