Viking Mission Support

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On April 26, 1976, the Network Operations Control Center was declared available for planetary operations in support of the Viking Project. This final capability in the Network configuration for Viking had been delayed since February with hardware and software problems both in the Control Center and at the Deep Space Stations. The effect of these problems, particularly insofar as they affected production of intermediate data records, the resolution of the problems, and the current status of the Network Operations Control Center in the Viking environment, is given in this article.

Also discussed are the Operational Verification Tests performed to check out the new capabilities and associated procedures. The Viking Project tests supported by the DSN and finally the DSN support of Viking cruise operations, along with some statistics on performance, are included.

I. Implementation

By January 1976, DSN implementation of the planetary configuration for Viking had progressed to the point where thirteen key items remained outstanding. These items were as follows:

(1) FR 2000 recorder to provide high-rate analog playback at all 64-m deep space stations.

(2) Occultation recorders to add two dedicated FR 1400 recorders to DSS 14 at Goldstone and DSS 43 in Australia to allow recording of Viking telemetry data simultaneously with occultation data.

(3) Replace A.B. Dick printers with G.E. Terminettes for higher speed and better reliability.

(4) Command backup printer to provide a second hard copy of all commands transmitted in case of printer failure.

(5) Auto Conscan to provide more accurate pointing of antenna for reception of X-band signals.

(6) Auto Track detectors and recorders to more accurately align RF boresight and verify antenna pointing.

(7) Provide ±1 MHz doppler bias in place of existing 5-MHz bias for better doppler resolution and offset of high doppler frequencies.

(8) Phase II version of Monitor software to accommodate both Block II and Block III receivers.

(9) Original Data Record (ODR) recall software to provide Network Operations Control Center with capability for recall of digital original data records directly from the deep space stations.

(10) Provide the Network Operations Control Center with an operational capability to generate intermediate data records from a Network Data Log and a gap list in conjunction with the original data record recall software.

(11) Permit the Network Control System tracking subsystem to accommodate the ±1 MHz doppler bias change.

(12) Increase the Mars radar X-band transmitter power to 400 kW.

(13) Provide additional technical staff, in lieu of the Station Monitor and Control Consoles (SMC IIA), at DSS 43 in Australia and DSS 63 in Spain to handle Viking planetary operations.

A schedule was developed that showed completion of all items except the FR 2000 and station staffing at DSS 63 by the end of February 1976. These two latter items were to be completed by March 15, 1976. All milestones were met with the exception of the Auto Conscan software at DSS 44 in Australia, the original data record recall, and intermediate data record production. The Auto Conscan problem having to do with an erroneous time change from one day to the next day over midnight was corrected by April 1, but the other two items continued to present new problems.

Early in March, the Network Operations Control Center began delivering intermediate data records to the Project during Viking demonstration test DT-4. During this period, the Network Operations Control Center operations crews were supported heavily by engineering development personnel.

The Network Operations Control Center was then turned over to the operations staff for more routine operational production of intermediate data records. Troubles immediately became apparent both at the stations and in the Network Operations Control Center. As a consequence, the DSN was not ready to support routine operations with the intermediate data records on April 1 as previously committed, and a special task team was established on March 29 to identify and correct the problems. A deadline for accomplishment of this task was set by the Viking Project for April 26.

Turning first to the station end of the system, four areas of improvement were identified as follows:

(1) Use of highest quality certified tape on 9-track high-density digital tape machines.

(2) More rigorous attention to tape recorder alignment and calibration.

(3) Record and playback on the same machines to minimize skew problems.

(4) Use of the new version of the intermediate data record recall software which provided, among other things, the ability to continue the operating in the "search" mode in the presence of a large number of tape read errors.

With these measures in effect at the stations, an immediate improvement in intermediate data record quality was noted, although reliability in the Network Operations Control Center hardware and software continued to remain poor.

Some statistics of intermediate data record production in the first two weeks following this work is given in Table 1.

At this point, the attention of the Task Team turned to the Network Operations Control Center itself, particularly the Network Data Processing Terminal (NDPT) and the Network Data Processing Area (NDPA) shown in Fig. 1. Specific issues considered essential to completion of an operational capability by April 26 were:

(1) Correct the intermediate data record summary statement of the number of data blocks expected and missed in real-time.

(2) Correct the signal level and signal-to-noise ratio statements on the intermediate data record summary.

(3) Provide a correct statement of the recall codes which give the reasons for blocks missed and the type of recall procedures initiated.

(4) Correct several errors in the gap detection logic that gave erroneous number of gaps or garbled messages when particular numbers of gaps were accumulated.

In addition to this work on the software running in the Data Records Processor, it was decided to provide an extra computer and magnetic tape unit in the Network Data Processing Terminal to perform the function of merging the recalled data with the real-time data. This additional "merge" capability permitted recall and merge activity to be carried out simultaneously, a capability considered necessary to meet the operational requirement of intermediate data record delivery within 24 hours of the end of each pass.

The software and hardware additions described above involved two weeks of intensive implementation and testing. Daily status meetings were held to resolve problems and reallocate priorities and resources. By April 21, all the work was completed and had passed through acceptance testing.

On April 22, the DSN Operations organization was briefed on the capabilities then available in the Network Operations Control Center. It was these capabilities, enhanced to some limited extent as time permitted, that the Network Operations Control Team will use to support Viking planetary operations.

With this capability delivered for operational support, the implementation task for Viking may be considered complete.

A number of known problems remain and some as yet unknown problems must be expected as the DSN configuration for Viking matures with operational use.

Improvements will always be desired or become necessary as the operations teams accumulate experience in the mission environment. These facts were recognized in committing the DSN to operational support. To the extent that the exigencies of the Viking mission permit, these issues will be resolved as they arise during the progress of the mission.

II. Testing and Training

A. Operational and Verification Tests

The basic objectives and scope of operational verification tests (OVTs) DSN-Viking Mission Control and Computing Center (VMCCC) system Integration tests (SITs) and ground data system (GDS) Tests are detailed in previous articles in this series (Refs. 1-4).

The OVTs in the period covered here were modified to operationally test the following previously untested items.

(1) 26 m–64 m joint failure mode configurations

(2) Automatic total recall system (ATRS)

(3) Intermediate data records (IDRs)

(4) Modified Viking command procedures

(5) New wide-band data lines (WBDL)

(6) New 64 m Configuration (Code 61) with dual high-speed data lines (HSDLs) to provide 100% redundancy for Viking Lander 1 (VL1) operations.

B. 26 m—64 m Joint Failure Mode Configurations

Four OVTs were scheduled for DSSs 11-14, 42-43, and 61-63, starting in December 1975 and completed in January 1976. The purpose of these tests was to exercise failure mode configurations documented in the Network Operations Plan which minimize data outage in the event of a hardware failure at the 64-m station during operations with three spacecraft. A summary of test results follows:

(1) *DSS 42 and 43 planetary failure mode OVT.* The final OVT was completed and was 100% successful.

(2) *DSS 61 and 63 planetary failure mode OVTs.* The last two OVTs were completed successfully. Success rating was 95% on OVT 3 and 100% on OVT 4.

(3) *DSS 14 planetary OVT.* Another objective of this test was to verify that the wideband data line was performing to specification. Secondary objective was to check performance of newly implemented, but not fully acceptance tested, automatic recall program. Test was completed successfully.

C. ATRS, IDR and Command Procedure OVTs

As described in detail in Sect. I, the ATRS-IDR capability was scheduled to be available for limited procedure generation and check out on Jan. 5, 1976, constituting the initial operator training on the system. Due to numerous hardware and software problems in this very complex system, the training actually started about mid-February.

During the month of March 1976 an OVT was scheduled for each of the nine DSSs along with the Network Operations Control Center (NOCC), using a sequence designed to exercise the recall functions by use of planned data outages, thus exercising all the functions necessary for the production of IDRs. These tests exercised the new telemetry recall program (DOI-5082-OP) and also the new 16-kb/s analog recall capability at the 64 m DSSs utilizing the FR 2000 analog recorders. The tests were very successful from a training viewpoint, although the number of 100% complete IDRs produced fell short of expectations and could be regarded as approximately 40% overall successful.

During March, IDRs were also produced from selected Viking Orbiter 1 (VO1) and VO2 spacecraft instrument calibration passes. This activity was supported by the personnel "in training," who were assisted and advised by the engineering personnel responsible for the development of the system. These passes resulted in a total of 80 IDRs being produced, 55 of which proved to be faulty.

As detailed in Sect. I, during this period a task team was formed to concentrate on the isolation and rectification of problems in the system, and the April 1, 1976 "fully operational" date for the system was moved to April 26, 1976 to enable the hardware, software, and procedural changes to be implemented. These changes have been extensively tested, and at the time of writing it appears that the system will successfully support the Viking planetary operations.

D. Modified Viking Command Procedures

The original DSN command system capabilities agreed to by the Viking project had a limitation where, in the event of a 360 computer or HSDL failure, the DSS could only manually send commands to the Viking Orbiter spacecraft in blocks of six commands. Further, if the failure occurred when the command system was in the idle 1 mode, the station could not effectively transmit any commands successfully from the preloaded stack. In this instance the DSS had to select "Cal-2" mode to set the "ACTIVE" flag which interrupted the idle sequence, and, as soon as the system went to "idle 2" the commands would immediately be promoted from the active stack and be radiated without the prerequisite idle sequence and therefore be aborted by the spacecraft.

This situation was known just prior to launch and a procedural work around was generated that corrected the situation without requiring any software changes. However, it was agreed not to introduce any changes at that time as the new procedures (both project and DSN) would invalidate the training just then completed. These new procedures were exercised successfully by every shift at every station, and after station on-site training had been completed, are now fully operational. This gives the capability for a DSS to manually recover successfully from an idle 1 situation and also to manually transmit 16 contiguous commands to the Viking Orbiter (VO) spacecraft.

These new command procedures were included in the sequence used for the nine OVTs discussed in Subsection B. The command procedures part of these tests were 100% successful at all stations.

E. New Wide-Band Data Lines (WBDLs)

To meet the Viking dual-station wideband planetary test and flight support requirements from DSSs 43 and 63, NASA Communications (NASCOM) activated a new wideband data channel JPL-Goddard Space Flight Center (GSFC) in early February 1976 via the new RCA domestic satellite routing. This new wideband (WB) service operates at 56 kb/s and provides dual (27.6 kb/s) wideband channels utilizing time division multiplexing (TDM) mode of operation. When first activated in support of the DSN OVTs, difficulties were experienced by NASCOM and the commercial carriers in getting this new facility to meet NASCOM transmission standards; however, the problems were resolved by mid-February 1976 and allowed the DSN and Viking project to meet the required dual-station wideband testing.

F. New DSS Configuration

Requests were received from the Viking Mission Control Team personnel for the DSN to examine the possibility of providing a full back up configuration to and from the overseas 64-m stations for the initial Viking Lander (VL) acquisition and subsequent 20 passes.

A reevaluation of the station configurations resulted in a new configuration (Fig. 1) which allows for processing of Orbiter engineering and science, while simultaneously processing the Lander engineering and science on four separate streams. The Lander data are first priority data during this period with engineering processed on two different streams, one routed via prime high-speed data line (HSDL) and the other via "back-up" high-speed data line. The lander science is also processed on two separate streams routed via high-speed data line and wide-band data line.

The two HSDLs terminate at JPL on two separate computers so that not only is there 100% redundancy on the VL telemetry data streams, but also the JPL-DSS command stream is duplicated from JPL through the station computers to the Command Modulation Assembly (CMA) exciter switch. This means that a failure anywhere from the JPL 360 computer, through the GCF, NASCOM and DSS can immediately be rectified by reselecting one switch at the DSS.

Three OVTs were scheduled to precede Demonstration Test No. 4 (DT-4) from Feb. 21, to Feb. 23, 1976, one for each 64-m station. The objective of these OVTs was to insure that station equipment was operational for DT-4 and operating personnel were exercised by following a realistic time-line simulating the Mars orbit insertion (MOI) and VL initial acquisition of the mission using Code 61 configuration. These tests were completely successful.

III. DSN Support of Additional Viking Testing

In addition to the OVTs discussed above, the DSN supported System Integration Tests (SITs), Ground Data System (GDS) Tests, and Demonstration Test Number Four (DT-4). See Ref. 4. The various tests are described in the following subsections.

A. System Integration Tests

DSS 14 completed SIT testing in November 1975. This report will cover tests for DSS 43 and 63 only. This testing did not occur earlier because planetary implementation was not completed at the overseas 64-m station until early January. A test summary follows:

1. **DSS 43 test.** All test items attempted were accomplished. Due to a number of delays encountered throughout the test, a retest was required.

2. **DSS 43 retest.** The following items were tested: DIS monitor software, Dual S- and X-Band doppler, Telemetry Data Rates not tested on previous SIT test, and the command procedures not exercised on previous SIT test. The SIT retest was successful. All test objectives were met.

3. **DSS 63 SIT test.** All SOE items were exercised, except DODR recall and dual S-band doppler. All items tested met test objectives. The test was considered successful and no retest was required.

SIT testing that could not be accomplished to date will be tested along with delinquent GDS items, in GDS 11.0 test, scheduled for the second week in May '76.

B. Ground Data System Tests

1. **DSS 11 and 14, GDS 5.31 retest.** The prime purpose for the retest was to test failure mode configurations that were not tested on first GDS test. Test objectives were not met and test was considered unsuccessful with a retest required.

2. **DSS 11 and 14, second 5.31 GDS retest.** 90% of test objectives were met. The test was considered successful with no retest required.

3. **DSS 43, GDS 5.32 test.** 95% of test objectives met. The test was considered successful with no retest required.

4. **DSS 63, GDS 5.32 test.** Major test objectives were met. The test was considered successful with no retest required.

5. **DSS 14, 43 and 63, GDS 6.0 test.** This was a 36-hour planetary GDS test designed to test the Ground Data System prior to beginning flight team testing. Only 80% of test objectives were met. Retest was required.

6. **DSS 63, GDS 6.0 retest.** This test did not require full resources originally used. DSS 63 was used for this test because of ease in scheduling time for test, not because items to be tested had failed at DSS 63 on first GDS test. Remaining objectives to be tested were successfully completed with this retest. GDS 6.0 was to be the final GDS test, but due to late implementation of several software programs and additional hardware, additional testing will be required. GDS 11.0, designed for this purpose, is a catchall GDS test and will be completed the second week of May 1976.

C. Demonstration Test Number Four (DT-4)

This was the first major project test exercising planetary configurations and procedures to simulate that part of the mission beginning 52 hours prior to lander touchdown and continued through lander pass No. 9. The total duration of this test was eleven days, but the DSN was required to participate for only three days, beginning at lander touchdown minus 37 hours and continuing through lander initial acquisition pass No. 1.

DSSs 11, 14, 43, and 63 were the participating stations for Demonstration Test Number Four (DT-4). The test was considered 100% successful.

The additional DSN testing and extra effort in preparing for DT-4 paid excellent dividends. The DSN support for DT-4 was rated as excellent by the test conductor. The test was also very productive as numerous items surfaced during the test that will require further refinements, and adequate time is available to accomplish these goals prior to orbital operations.

With the successful completion of DT-4, the DSN and the Viking Project have met an important milestone in the overall readiness of the DSN to support Viking Planetary Operations.

IV. DSN Support of Cruise Operations

Viking spacecraft activities during the cruise to Mars have required a very high level of support from the DSN. The level of activity and complexity of this support have approached that anticipated during planetary operations and have generally exceeded that of the planetary test exercises as well. A summary of the major cruise support activities is provided in the following subsections.

A. Significant Mission Events

Table 1 lists the significant Viking cruise activities that have been supported by the DSN thus far in Calendar Year 1976. Many of the spacecraft activities required the transmission of large numbers of commands and/or processing of multiple telemetry streams, including the highest Viking data rate (16.2 kbits/s) by the stations. These activities also imposed a workload on the Network Operations Control Center (NOCC) and Ground Communications Facility (GCF) far beyond that which would be expected in a normal "quiet cruise."

B. DSS Support

While Table 1 illustrates the magnitude and complexity of the Viking mission events supported by the DSN, Table 2 depicts the extent of support provided by the Deep Space Stations in terms of the total number of passes, tracking hours, and commands transmitted. The only major outage to occur at a DSS since January 1 was an antenna servopump motor failure at DSS 44 that required scheduling adjustments for the period March 9 through 12 to avoid large gaps in Viking coverage. The schedule was adjusted to meet the Viking Project requirement of no gaps to exceed 3 hours, and the impact on operations was minimal.

C. Network Operations Control Center (NOCC) Operations

Implementation of the NOCC continued throughout this reporting period under the Network Control System (NCS) Project. A number of unexpected problems caused delays in subsystem delivery schedules and will result in an incomplete transfer of the NOCC to operations on July 1 as planned. A major effort was concentrated on meeting the DSN commitment to the Viking Project for Intermediate Data Record production, which required the completion of an operable NOCC telemetry subsystem. This requirement was met and IDR production was accomplished in support of Viking operations after March 1. Training of operations personnel to perform the functions involved in the routine generation of IDR products during the prime mission planetary operations was conducted throughout this reporting period and is now 80% complete. Final operations procedures and system problems workarounds were addressed by an IDR investigation team formed by DSN operations and will be completed by May 1.

D. DSN Discrepancy Report Status

Table 3 summarizes failures and anomalies in Viking committed Network resources as documented by the Discrepancy Report (DR) System. The chart covers the first quarter of the calendar year. The station dependent number is unusually high due to continued development of new capabilities being demonstrated for the first time in support of the Viking Project.

The remaining open DR's are under active investigation and are of no immediate impact to operations.

References

1. Mudgway, D. J., and Johnston, D. W., "Viking Mission Support," in *The Deep Space Network Progress Report 42-26*, pp. 8–16, Jet Propulsion Laboratory, Pasadena, Calif., April 15, 1975.

2. Mudgway, D. J., et al., "Viking Mission Support," in *The Deep Space Network Progress Report 42-27*, pp. 10–27, Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1975.

3. Mudgway, D. J., and Johnston, D. W., "Viking Mission Support," in *The Deep Space Network Progress Report 42-30*, pp. 57–60, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1975.

4. Mudgway, D. J., et al., "Viking Mission Support," in *The Deep Space Network Progress Report 42-29*, pp. 10–14, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1975.

Table 1. Intermediate data record statistics

Date	Pass	DSS	Rate, bits/s	Blocks received in real-time	Blocks missed in real-time	Blocks missing after recall	Percent delivered
4/8/76	DT-7	43	8K/2K	23393	Not available	3	99.9
			8K	16160		9	99.9
	DT-7	43	250	1118		0	100
			250	529		0	100
4/11/76	DT-7	43	2K/8K	23010		6	99.9
			2K/8K	6923		0	100
			250	274		0	100
4/12/76	237	63	2K	10628		47	99.6
			8K	23650		109	99.6
			8K	5278		9994	
			2K	3628		2	
4/11/76	236	63	2K	22184		82	99.6
4/14/76	219	63	2K	9981	101	0	100
4/15/76	220	63	2K	8716	10	0	100
			2K	4798	7	0	100
			8K	23755	30	1	99.99
			2K	13941	1	0	100
4/16/76	221	63	1/2K	6714	34	34	99.496
			8K	73343	850	92	99.875
4/17/76	241	14	8K	80895	2	2	99.998
	252	63	8K	38092	2034	13	99.96
			1/2K	8132	30	30	99.63
4/20/76	DT-4R	63	16K	19021	91	21	99.89
4/21/76	DT-4R	14	8K	47775	3250	13	99.98

Blocks Received in Real-Time means the number of wideband blocks received on the Network data log in real-time as the data are delivered to the Mission Control and Computing Center.

Blocks Missing After Recall means the number of blocks which were not available after one recall operation from the digital original data record at the station.

Blocks Recalled means the number of blocks recalled from the station digital original data record by the Network Operations Control Center recall process or working in conjunction with the ATRS recall software at the station.

Percent Delivered means the percentage of total blocks on the digital original data record that were delivered on the intermediate data record.

Table 2. Viking significant events supported by the DSN

Date	Spacecraft	Activity
Jan. 5	Orbiter 1	Mars atmospheric water detector (MAWD) calibration
Jan. 5	Lander 2	Tape recorder maintenance
Jan. 6	Orbiter 1	High-gain antenna (HGA) calibration utilizing DSS 14 X-Band capability
Jan. 7	Lander 1	Tape recorder maintenance
Jan. 7	Orbiter 1	MAWD calibration
Jan. 8	Lander 1	Gas chromatograph mass spectrometer (GCMS) bakeout number 2
Jan. 13	Lander 2	GCMS oven characteristics sequence
Jan. 14	Lander 1	GCMS bakeout number 2
Jan. 14	Orbiter 2	X-band telemetry experiment
Jan. 15	Lander 2	Tape recorder maintenance
Jan. 16	Lander 1	Tape recorder maintenance
Jan. 16 & 17		X-Band telemetry experiment
Jan. 20	Lander 2	GCMS oven characteristics sequence
Jan. 28	Lander 1	GCMS oven characteristics sequence
Jan. 31	Lander 2	GCMS bakeout
Feb. 2	Lander 1	GCMS oven characteristics sequence
Feb. 3	Lander 2	Tape recorder maintenance
Feb. 4	Lander 1	MAWD calibration
Feb. 6	Lander 2	GCMS vents
Feb. 7	Lander 1	GCMS bakeout
Feb. 9	Lander 1	Infrared thermal mapper calibration
Feb. 9	Orbiter 1	Visual imaging subsystem (VIS) scan calibration
Feb. 10	Lander 2	Power conditioning sequence (battery charge/discharge)
Feb. 11	Orbiter 2	MAWD calibration
Feb. 11	Lander 2	Tape recorder maintenance
Feb. 12 & 13	Lander 1	GCMS bakeout
Feb. 13	Orbiter 2	Infrared thermal mapper calibration and VIS scan calibration
Feb. 15	Orbiter 2	VIS scan calibration playback
Feb. 17	Lander 1	GCMS vents 4 and 5 close and atmospheric analysis
Feb. 18	Orbiter 1	Tape recorder maintenance and HGA calibration
Feb. 19	Lander 1	Power conditioning sequence
Mar. 8	Orbiter 1	MAWD calibration
Mar. 8	Orbiter 2	Tape recorder maintenance
Mar. 10	Lander 1	Tape recorder maintenance
Mar. 10	Orbiter 1	HGA calibration
Mar. 11	Orbiter 2	MAWD calibration
Mar. 11	Lander 2	Tape recorder maintenance
Mar. 15	Orbiter 2	Accelerometer and gyro calibration
Mar. 16	Orbiter 2	Photo calibration
Mar. 16	Orbiter 1	Tape recorder maintenance
Mar. 18	Orbiter 1	Accelerometer and gyro calibration
Mar. 22	Lander 1	Inertial reference unit (IRU) number 2 calibration
Mar. 23	Orbiter 1	Photo calibration
Mar. 22 - 24	Orbiter 1 & 2	Playback of photo calibration data
Mar. 26	Lander 2	IRU number 2 calibration
Mar. 27	Orbiter 1	HGA calibration
Apr. 11	Orbiter 1	Onboard computer software update
Apr. 12	Orbiter 1	Scan calibration
Apr. 14	Orbiter 2	Onboard computer software update
Apr. 15	Orbiter 2	Scan calibration
Apr. 16	Orbiter 2	VIS picture playback
Apr. 16	Lander 2	Tape recorder maintenance
Apr. 17	Orbiter 1	VIS playback
Apr. 17	Lander 1	Battery charge and tape recorder maintenance
Apr. 18	Orbiter 2	Very long baseline interferometer (VLBI) with quasar source

Table 3. DSS support of Viking cruise operations

Month	DSS	No. of passes	Hours tracked	Commands transmitted
January	11	10	71:30	100
	12	25	211:26	245
	14	15	112:29	324
	42	8	35:55	0
	43	24	150:09	21
	44	27	183.36	20
	61	14	107:55	191
	62	36	309:29	345
	63	12	117:55	0
Monthly total:		171	1300:24	1246
February	11	2	04:54	0
	12	32	278:52	564
	14	11	99:38	15
	42	31	139:33	21
	43	17	124:05	59
	44	11	48:25	13
	61	4	37:51	0
	62	32	290:13	624
	63	24	219:47	556
Monthly total:		164	1243:18	1852
March	11	15	71:16	17
	12	24	171:31	302
	14	17	124:23	0
	42	17	62:33	0
	43	20	101:23	0
	44	26	131:04	197
	61	7	67:03	0
	62	31	276:30	259
	63	32	299:21	338
Monthly total:		189	1305:04	1113
Report total:		524	3848:46	4211

Table 4. Viking Discrepancy Reports, Jan. 1 to Mar. 31, 1976

Resolution	DSS 11	DSS 12	DSS 14	DSS 42	DSS 43	DSS 44	DSS 61	DSS 62	DSS 63	MIL 71	Net-work	Com-muni-cations	NDPA	NOCA	Total
Facility dependent	21	24	106	29	64	19	24	24	53	16	5	24	20	28	457
Facility independent	4	5	8	7	3	0	0	3	3	1	2	6	5	12	59
Other or unavoidable	2	2	2	0	1	0	0	1	0	1	9	4	1	2	25
Total DRs closed	27	31	116	36	68	19	24	28	56	18	16	34	26	42	541
Total DRs generated	29	33	128	38	75	19	26	29	81	18	17	34	41	46	614
DRs open as of Mar. 31, 1976	2	2	12	2	7	0	2	1	25	0	1	0	15	4	73

NDPA = Network Data Processing Area
NOCA = Network Operations Control Area

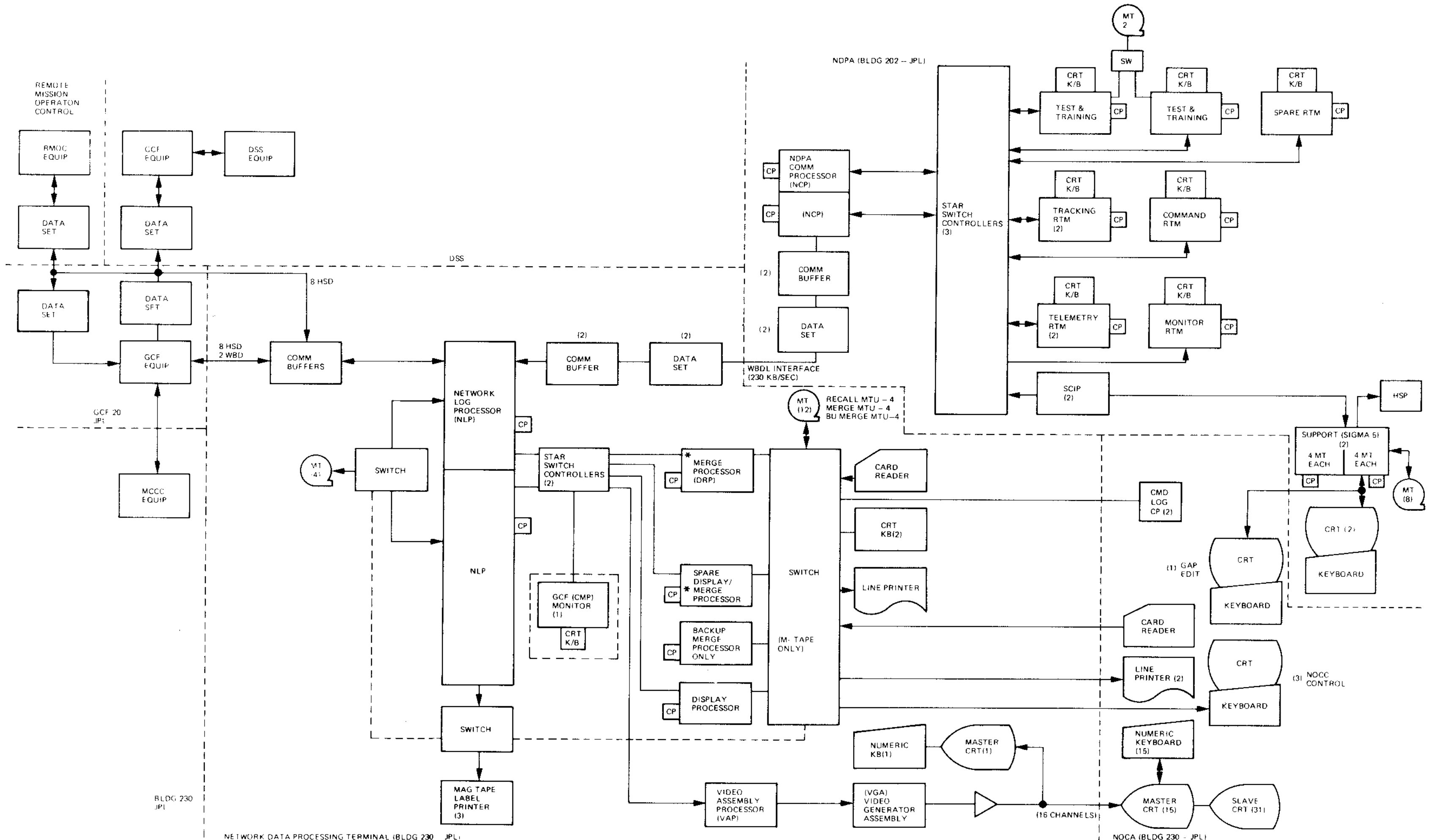

Fig. 1. Network Operations Control Center block diagram, 1976 to 1977

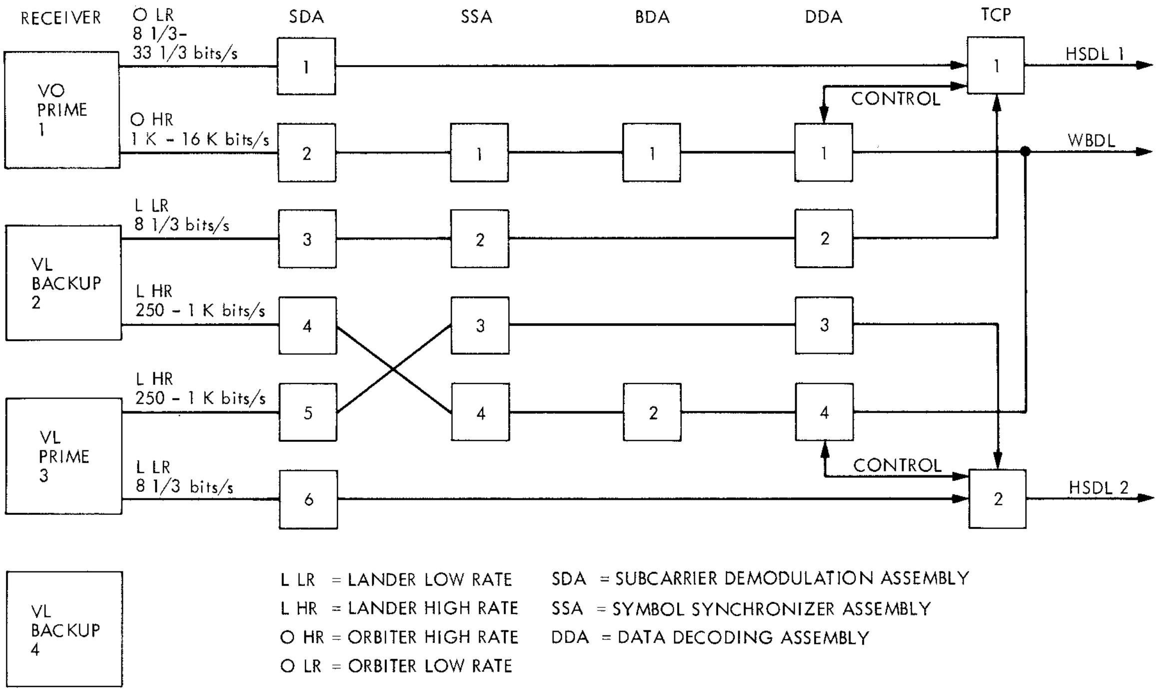

Fig. 2. Station configuration for four data streams