Apollo Mission Support

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The support provided by the Deep Space Network (DSN) to the Manned Space Flight Network (MSFN) during the Apollo 14 mission is described. Support was provided from the three 26-m (85-ft) DSN/MSFN Wing stations, the Goldstone 64-m (210-ft) antenna, the Ground Communications Facility, and the Space Flight Operations Facility. Premission and mission activities are discussed and a brief mission description is included.

I. Introduction

The DSN support provided to the MSFN for the past *Apollo* lunar missions has been described in Ref. 1 and earlier issues of the Space Programs Summary Volume II series. This article describes the support provided for the *Apollo 14* (AS-509) mission, the third successful manned lunar landing.

II. Mission Description

Apollo 14 was the seventh manned *Apollo* mission flown above the three-stage *Saturn V* launch vehicle and carried astronauts Alan B. Shepard, Jr. (Commander), Stuart Allen Roosa (Command Module Pilot), and Edgar Dean Mitchell (Lunar Module Pilot). The mission goal was to land in the Fra Mauro uplands, the same goal that the abortive *Apollo 13* mission was unable to achieve. The *Apollo 14* mission successfully accomplished its objectives in spite of a large number of minor problems, which are mentioned in the following discussion.

Launch from Cape Kennedy Pad 39A occurred at 21:03:02.9 GMT on January 31, 1971, at a launch azimuth of 75.56 deg. The launch had originally been scheduled for a 20:23 GMT launch, but a launch hold of some 40 min was required due to the new weather restrictions developed after the lightning strikes of *Apollo 12*. This was the first time a manned *Apollo* mission was not launched on time. Injection into translunar trajectory occurred midway through the second revolution in the Earth parking orbit with a 5-min 49-s burn of the S-IVB-stage engine.

Following translunar injection (TLI), the Command/Service Module (CSM) separated from the booster and attempted to dock with the unattended Lunar Module (LM). For the first time on *Apollo*, this docking procedure was unsuccessful, with the capture latches of the docking probe failing to seize the Lunar Module drogue. Without a successful docking there would be no lunar landing, although the crew was in no danger. The docking had to be accomplished within several hours before the S-IVB attitude-control system became inoperative and the S-IVB and Lunar Module started to tumble. Under direction from Mission Control Center in Houston, the astronauts made five additional docking attempts in various configurations. On the sixth attempt, docking was successful.

After docking, the probe was removed from the Command Module/Lunar Module tunnel for examination. No abnormal behavior or contamination could be detected, and the mission was given the "go-ahead" for lunar landing. After separation from the spacecraft, the S-IVB (the launch vehicle third stage) was directed toward a crash on the Moon as a calibration of the seismometer left there during the *Apollo 12* mission. The impact occurred at 07:40:55 GMT on February 4, 1971, at lunar coordinates 8 deg 03 min S, 26 deg 03 min W, approximately 174 km southwest of the seismometer which showed vibrations for some 2 h.

Midcourse correction 1 was deleted due to the accuracy of the translunar injection maneuver. Midcourse correction 2 was executed at 03:39 GMT on February 2, 1971, removing the spacecraft from its "free-return" trajectory to save fuel for the lunar landing sequence. The remainder of the translunar cruise was nominal except for an observed dip from 37.0 to 36.7 V in one of the Lunar Module ascent stage batteries. This dip, first noticed during the Lunar Module checkout at 10:56 GMT on February 3, caused some concern and a test was executed at 02:38 GMT, February 4, which confirmed that the battery would properly support a load.

Other minor problems during translunar coast included difficulty in maintaining correct pointing of the spacecraft high-gain antenna and a high rate of pressure decrease during a cabin leak check. The latter problem was caused by a urine vent valve being accidently left open. Midcourse correction 3 was deleted but a small midcourse correction 4 was executed at 02:01 GMT, February 4, with the burn lasting less than 1 s.

A successful lunar orbit insertion (LOI) burn put the spacecraft in a 315- by 110-km (169.6- by 58.9-nmi) elliptical orbit. Two orbits later a descent orbit insertion (DOI) burn changed these dimensions to 110 by 17.2 km (59.0 by 9.3 nmi). During lunar orbit, additional pointing problems with the high-gain Command/Service Module antenna were experienced.

During lunar orbit 12, the Command/Service Module and Lunar Module separated with astronauts Shepard and Mitchell in the Lunar Module preparing for descent to the lunar surface on orbit 14. Difficulty was experienced maintaining lock on the Lunar Module high-gain antenna, but behavior was normal on the next orbit. An abort pushbutton sent erroneous inputs to the Lunar Module guidance computer on four occasions. The button may have been defective or contaminated since tapping on the switch panel cleared up the problem. The computer was reprogrammed to ignore these abort inputs.

During the descent phase, the landing radar came on in the "near" mode [1066.8 m (3500 ft) maximum] instead of the "far" mode. This problem was first noticed when the radar failed to acquire lock when passing through 9.15 km (30,000 ft). The radar was turned off and on, and lock was acquired.

The landing was normal and was within 20 m of the intended landing site. After more than 5 h of preparation, the two astronauts began their first excursion during which surface samples were collected, the ALSEP[1] and TV camera were deployed, and the "thumper" was activated. The "thumper" is a hand-held rod which taps the lunar surface as a small explosive charge within it is detonated. This device proved to be especially unreliable, and the astronaut was able to detonate only 13 of the 21 charges. Due to this problem and several others including difficulty unfolding the S-band erectable antenna, a twisted urine tube in the Commander's suit, a broken wrist cable in the Lunar Module Pilot's suit, and an EVA (extra-vehicular activity) radio problem, the astronauts fell behind their planned timeline and were unable to complete all assigned tasks.

During the ensuing rest period, an S-band bistatic radar experiment was conducted between the orbiting Command/Service Module and DSS 14. This experiment is discussed below. Also during the rest period, the Lunar Module astronauts conducted a pressure check of the space suits to confirm that an abnormally high leak rate on the Lunar Module Pilot's suit had not increased to the danger level. All was in order and the astronauts began the second excursion 2 h and 28 min ahead of schedule. This excursion was to take the astronauts 1000 m to the edge of Rim crater. Although this goal was not

[1] *Apollo* lunar surface experiments package.

quite reached, many rock samples of new and different types were collected.

Lunar liftoff, rendezvous, and docking were normal with none of the problems of the earlier docking. Following transfer of the lunar samples to the Command/Service Module, the LM was jettisoned and directed toward a crash on the Moon near the ALSEP seismometer. One orbit later, on orbit number 35, the crew executed the trans-Earth injection burn to start the return trip to Earth.

Apollo 14 landed at approximately 172 deg W, 27 deg S, midway between Samoa and New Zealand.

Table 1 shows the mission event times and Table 2 gives the television coverage. Care must be exercised when using ground elapsed time (GET), which on previous missions recorded the time from launch. With *Apollo 14's* launch slip (the first on *Apollo*), the clock carries a different meaning. In order to make the sun angles upon lunar landing identical to the premission plans, the translunar trajectory was made 40 min faster than planned. The GET clock was then set forward 40 min and 3 s at 03:38:03 GMT on February 3. A new clock, actual elapsed time (AET), records the time from launch, and the GET clock is merely a convenient reference time which corresponds very closely to the planned mission timeline.

Table 1. *Apollo 14* sequence of major events

Event	Ground elapsed time, h:min:s	Actual elapsed time, h:min:s	Greenwich Mean Time, h:min:s
Launch	00:00:00	00:00:00	Jan 31/21:03:03
TLI ignition	02:28:30	02:28:30	Jan 31/23:31:33
TLI cutoff	02:34:19	02:34:19	Jan 31/23:37:22
First midcourse (TLI + 9 h)	Deleted		
Second midcourse (to hybrid) (TLI + 28 h)	30:36:07	30:36:07	Feb 02/03:39:10
Begin bistatic frequency measurement	52:20:00	52:20:00	Feb 03/01:23:03
End bistatic frequency measurement	52:25:00	52:25:00	Feb 03/01:28:03
Change ground elapsed time	55:15:03	54:35:00	Feb 03/03:38:03
Begin LM inspection	60:59:00	60:18:57	Feb 03/09:22:00
Third midcourse (LOI − 22 h)	Deleted		
Fourth midcourse (LOI − 5 h)	77:38:13	76:58:10	Feb 04/02:01:13
Second LM inspection (30 min)	78:14:58	77:34:55	Feb 04/02:37:58
CSM first occultation	82:23:03	81:43:00	Feb 04/06:46:03
Lunar orbit insertion	82:36:43	81:56:40	Feb 04/06:59:43
S-IVB impact	83:17:55	82:37:52	Feb 04/07:40:55
Descent orbit insertion	86:50:55	86:10:52	Feb 04/11:13:55
Undock	104:28:03	103:48:00	Feb 05/04:51:03
CSM circularization	105:46:48	105:06:45	Feb 05/06:09:48
Powered descent initiation	108:42:01	108:01:58	Feb 05/09:05:01
Touchdown	108:55:14	108:15:11	Feb 05/09:18:14
Begin EVA-1	114:20:00	113:39:57	Feb 05/14:43:00
ALSEP activated	117:05:00	116:24:57	Feb 05/17:28:00
ALSEP high-bit rate on	117:36:00	116:55:57	Feb 05/17:59:00
ALSEP high-bit rate off	118:14:00	117:33:57	Feb 05/18:37:00
End EVA-1	119:04:00	118:23:57	Feb 05/19:27:00
Begin bistatic radar	130:05:00	129:24:57	Feb 06/06:28:00
End bistatic radar	131:04:00	130:23:57	Feb 06/07:27:00
Begin EVA-2	131:48:14	131:08:11	Feb 06/08:11:14
End EVA-2	136:19:00	135:38:57	Feb 06/12:42:00
LM ascent	142:25:43	141:45:40	Feb 06/18:48:43
CSM/LM docking	144:12:00	143:31:57	Feb 06/20:35:00
LM separation	146:25:00	145:44:57	Feb 06/22:48:00
LM deorbit burn	147:54:00	147:13:57	Feb 07/00:17:00
LM crash	148:22:25	147:42:23	Feb 07/00:45:25
Trans-Earth injection	149:16:04	148:36:01	Feb 07/01:39:04
Fifth midcourse	166:14:00	165:33:57	Feb 07/18:37:00
Splashdown	216:42:01	216:01:58	Feb 09/21:05:01

Table 2. *Apollo 14* television

GMT, h:min	GET, h:min	AET, h:min	Duration, h:min	Subject	Vehicle	Station[a]
Feb 1/00:07	03:04	03:04	01:55	Transportation and docking	CSM	GDS
Feb 1/08:09	11:06	11:06	01:06	Inspection of docking probe	CSM	GDS
Feb 3/09:04	60:41	60:01	00:41	Interior of spacecraft	CSM	HSK
Feb 5/14:56	114:33	113:53	06:30	EVA-1	LM	HSK/MAD
Feb 6/07:34	131:11	130:31	05:20	EVA-2	LM	GDS/HSK
Feb 6/20:12	143:49	143:09	00:09	Rendezvous	CSM	MAD
Feb 6/20:27	144:04	143:24	00:10	Docking	CSM	MAD
Feb 8/01:21	171:58	171:18	00:51	Inflight demonstrations	CSM	GDS
Feb 8/23:31	195:08	194:28	00:25	Press briefing	CSM	GDS

[a]GDS = Goldstone MSFN station
HSK = Honeysuckle MSFN station, Australia
MAD = Madrid MSFN station, Spain

III. Requirements for DSN Support of *Apollo 14*

A. DSN/MSFN Wing Stations

As was done during previous *Apollo* lunar missions, DSSs 11, 42, and 61 were committed to support *Apollo 14* under direct MSFN/MSC control starting at launch minus 2 wk through the end of the mission.

B. DSS 14

The Mars station, DSS 14, was required to receive voice, telemetry, biomedical, and TV and relay the data to the Goldstone Prime MSFN station (GDS). Specific requirements existed for lunar landing, EVA television, and LM crash. Coverage was also desired for television during translunar coast.

C. Precision Doppler Data

As part of a continuing study of lunar potential anomalies (mascons), DSS 14 was required to provide precision doppler recordings of the Command/Service Module during several low lunar orbits and of the Lunar Module during the descent phase and later during the crash. An additional internal DSN requirement was levied for more doppler data during all low Command/Service Module orbits and several adjoining high orbits in support of a JPL study of mascons (with the same principal investigator who originated the formal requirement). As one can see from the timeline (Fig. 1), one pass from DSS 62 was necessary to provide almost complete coverage of this requirement. A related requirement was for high-speed strip-chart recordings of DSS 14 received signal level during orbit 3 of the Command/Service Module, descent and touchdown of the Lunar Module, and the crash of the Lunar Module.

D. Bistatic Radar Experiment

On April 14, 1969, Stanford University submitted a formal proposal to NASA to conduct an experiment, *Downlink Bistatic Radar Study of the Moon,* using DSS 14. The specific goals of this experiment are:

(1) To determine the Brewster angle of the lunar crust at S-band.

(2) To measure the spectral properties of bistatic radar echoes from low-altitude orbit.

(3) To gain operational experience with *Apollo* systems and operations as an aid in the design of future bistatic radar experiments.

The experiment should reveal fundamental new scientific information on the upper few centimeters of the lunar crust through a short wavelength determination of the Brewster angle of the lunar surface, and should provide engineering data necessary for optimizing the design of future bistatic radar experiments from low lunar orbits (approximately 100-km altitude). Furthermore, the results should provide a lunar S-band, bistatic radar calibration which would have considerable utility in the

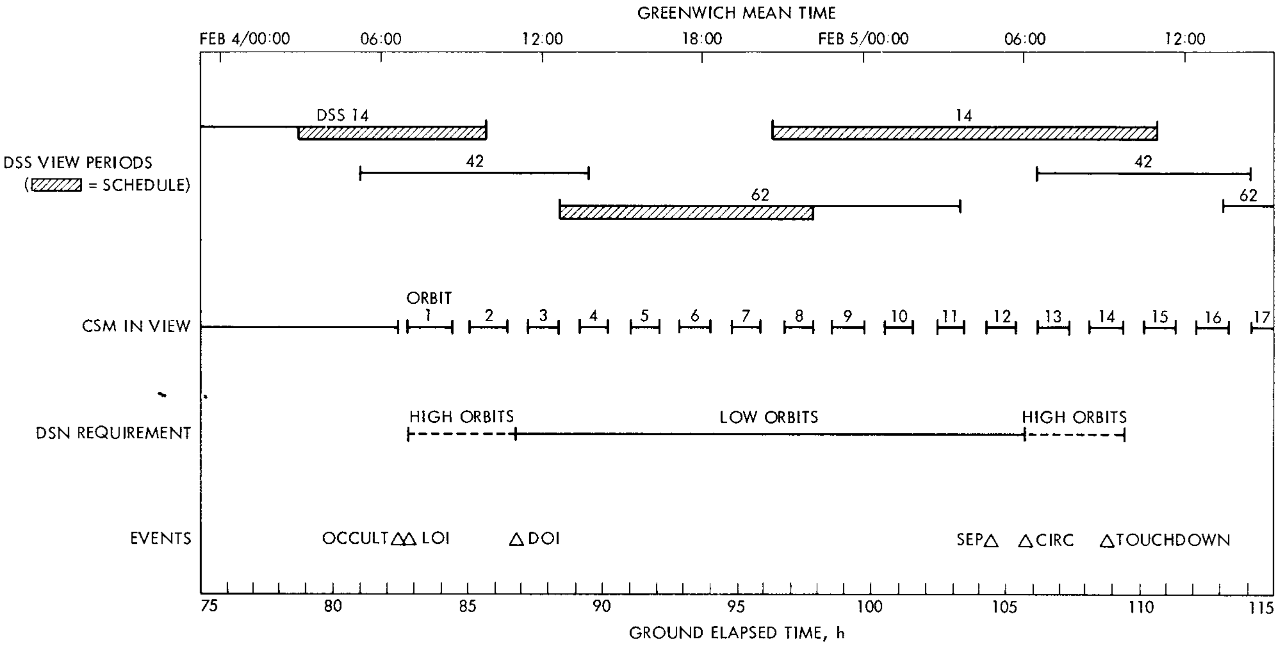

Fig. 1. DSN internal mascon study requirement

interpretation of similar experiments conducted in the future at the planets.

It was proposed that the downlink CSM S-band signal would be directed toward the lunar surface. At DSS 14 the reflected signal (and a portion of the direct signal) would be received in two polarizations simultaneously using the polarization diversity S-band cone. The outputs of the two receiver chains would be recorded on FR 1400 recorders.

E. Goldstone Timing Synchronization

An obsolete time sync agreement in effect since *Apollo 11*, which provided for routine measurements with a DSIF portable cesium clock at all Goldstone/*Apollo* support sites, was amended on June 9, 1970. The new agreement, which will be valid for all future *Apollo* missions, is as follows:

> A one pulse-per-second tick is distributed via DSN microwave to DSS 14. The pulse originates in the DSIF Standards Laboratory, arrives at the sites with known offsets, and is accurate to better than 5 μs. This signal is made available to the MSFN at the MSFN microwave interface at DSS 14. The portable cesium clock will be used only to calibrate the microwave delays when changes have occurred to the microwave system. Routine support of the portable clock will be discontinued. In the case of a bona fide timing emergency, the portable cesium clock will be available with a delay of 2 h during the normal working day and 48 h otherwise. Following any clock trip a TWX giving the results with respect to the National Bureau of Standards and the expected National Bureau of Standards–U.S. Naval Observatory offset will be sent out to interested parties.

F. Twenty-Kilowatt Uplink

Original plans for the operation of the Wing stations were for two simultaneous 10-kW radiated uplink signals. This was accomplished using two 20-kW transmitters fed into a combiner which introduced a 3-dB loss. Thus, 10 kW of power from each transmitter was radiated from the antenna. The other 10 kW from each transmitter, which was lost in the combiner, was dissipated in a 20-kW water load. When transmitting a single uplink, there was no longer a need for the combiner and its accompanying 3-dB loss, and a nonstandard configuration was entered at some Wing sites which bypassed the combiner, allowing a single 20-kW radiated power uplink. Unfortunately, since this was not a standard configuration, the combiner water load interlock was not disabled; that is, any failure in the water load would shut down the transmitter, even though the water load was not in use. No changes could be authorized because the radiation of a single 20-kW uplink had never been requested or committed.

On June 12, 1970, GSFC levied an official requirement upon the DSN for the 20-kW capability. An Engineering Change Order was issued to disable the water load interlock when in the 20-kW configuration. The modifications were completed in November 1970. Certain operational limitations remain:

(1) There exists no backup 20-kW capability since the installed microwave switching gear allows only one transmitter (the DSN transmitter) to be switched around the combiner.

(2) All uplinks must be turned off before any microwave switching can occur.

G. Wing Site Support of ALSEP

ALSEP communications are usually accomplished using the 30-ft antennas of the MSFN. In September 1969, the DSN received a requirement for the Wing sites to track ALSEP during the Active Seismic Experiment on ALSEP No. 4 during the *Apollo 14* mission period. During this new experiment, the ALSEP transmits at 10.6 kbits/s, a higher rate than past ALSEPs and beyond the capability of the 30-ft stations. The experiment is dubbed the "thumper" because of a series of small charges which are actuated by the astronauts to generate artificial seismic waves.

IV. *Apollo* Interface Team

Between *Apollos 13* and *14*, the DSIF was reorganized to eliminate the separate positions of Operations Engineering, Operations Planning, and System Data Analysis (SDA) for *Apollo*. Instead the DSIF planning efforts are represented by a single DSIF Operations Project Engineer for *Apollo*, and some of the operations functions, such as predict generation, have been assumed by the DSN mission independent operations organization.

V. Premission Preparations and Testing

A. DSN/MSFN Wing Stations

DSSs 11, 42, and 61 were placed under configuration control for the *Apollo 14* mission as of 00:01 GMT on January 17, 1971, and subsequently placed on mission status by the MSFN as of 00:01 GMT on January 21, 1971. Prior to January 21, each Wing site conducted extensive maintenance and testing of the equipment common to the DSN and MSFN. The new requirement for Wing support of the ALSEP indicated a need for ALSEP premission testing. The downlink tests pose no problem, but the ALSEP uplink frequency (2119 MHz) is at the extreme end of the normally used band (MSFN: 2100–2110 MHz; DSN: 2110–2118 MHz). Some tuning of the klystron power amplifier is therefore needed. Unfortunately, the klystrons may be retuned only a finite number of times before the cavity adjustment screws will bind up, requiring costly and time-consuming repair. In order to maintain these klystrons in good condition for the mission, the DSN limited the MSFN to one ALSEP uplink test at each Wing site. These tests, conducted on January 11 and 12, failed at all three Wing sites due to identical intersite microwave problems unrelated to the klystrons. It is unfortunate that the results of the first test were not applied to the second and third site. Nevertheless, the MSFN requested additional testing and, after management discussions, one additional test at each site (January 23 and 24) was allowed. Later investigation may show that this testing is related to the transmitter problems experienced during the mission.

B. DSS 14

In addition to the bistatic experiment tests and the predict tests mentioned below, DSS 14 conducted two tests before the *Apollo 14* mission (see Table 3). The first was an officially required participation in Day 5 of the MSFN network readiness test. DSS 14's participation turned out to be nothing more than a data transmission test between the DSS 14 communications center and the Goldstone MSFN station. The second test was an internal DSIF configuration verification test on January 19. The third test was an extensive data flow test with a spacecraft simulator used at DSS 14 to generate data which were fed through the entire system ending at the Goldstone MSFN station. Due to delays the test required more than the alloted 24 h on January 21, and the television and Lunar Module tests were rescheduled on January 27. Configuration control was imposed on DSS 14 on January 17.

C. Bistatic Experiment Preparations

A meeting was held at JPL on May 8, 1970 to discuss the feasibility of the proposed experiment. In attendance were representatives of MSC, GSFC, NASA Headquarters, North American Rockwell, Stanford University, and the DSN, DSIF, and GCF. The potential problem areas were identified and a number of action items were assigned. Shortly afterward a support requirement was issued at MSC (May 19, 1970). The final details on the configuration at DSS 14 were discussed at another meet-

Table 3. DSS 14 tests

Date	Time, h:min	Test	Comments
12/21/70	16:00–24:00	Bistatic cable installation	
12/22/70	22:00–02:01	Bistatic equipment checkout	
12/23/70	02:01–06:00	Bistatic track of *Pioneer VI*	Receivers 3 and 4 not yet installed; no 152.4 cm/s (60 ips) narrow-band frequency modulation FR 1400 modules
01/08/71		Day 5 of network readiness test	Data transmission test
01/08/71	22:30–05:30	Bistatic test	During *Pioneer VI* track; used *Pioneer VI* signal; FR 1400 not available
01/19/71		Configuration verification test	
01/21/71	14:20–14:20	Data flow test (24 h)	
01/27/71	14:18–22:17	Data flow test	TV and LM tests
01/28/71	20:00–07:10	Bistatic final calibration	

ing at JPL on November 9, 1970 with approximately the same representation as the May 8 meeting.

A number of installation periods and tests were conducted from late December 1970 until launch on January 31. These tests are included in Table 3.

D. DSN Predicts

Predict data for DSS 14 is generated in two ways. The prime method uses state vectors supplied by Houston MSC or Goddard Space Flight Center, and generates DSN predicts in the SFOF computers. The backup system involves a 29-point acquisition message generated at MSC, transmitted directly via TTY to DSS 14, and converted at DSS 14 from X–Y to HA–dec coordinates with an atmosphere refraction correction added if necessary.

In November 1970 the DSIF served notice that it would not allow further use of the 29-point conversion program because the software had never been properly certified or documented, even though it had been successfully used on several *Apollo* flights. To make matters worse, the SFOF IBM 7094/7044 computer system was about to be removed to make way for a second IBM 360/75, and it was uncertain if the predict software for the 360 would be ready for *Apollo*.

Several compromises were necessary. The 7044 was removed, but the 7094 was merely moved to a new location in the SFOF. The 7094, however, lacked a high-speed printer (used for checking the predicts), adequate tape drives (to lessen the required tape changes), and a 7044 to transmit the predicts.

The missing 7044 was overcome by the procedure shown in Fig. 2. A state vector received in the SFOF was input to the 7094. The output tape was then carried to the PDP-7 computer in the Media Conversion Center of the SFOF where the predicts were transferred to TTY punched paper tape. This tape was taken to a tape reader in the Communications Center, where a TTY header was added, and the data was transmitted. A test of this system on January 18 was successful except for a bad TTY punch in the Media Conversion Center. The test was repeated on January 19 with complete success. In an effort to obtain clearance to use the 29-point conversion program, a number of tests were conducted starting in December 1970. The last tests on January 12 and 22 resulted in acceptance on an emergency backup, best-effort basis only.

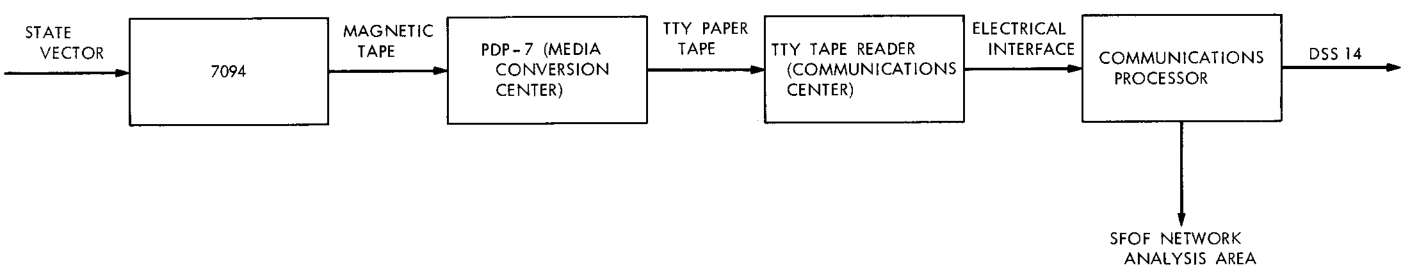

Fig. 2. DSN predict generation for *Apollo 14*

VI. *Apollo 14* Operations

A. DSN/MSFN Wing Stations

DSSs 11, 42, and 61 successfully supported all phases of the *Apollo 14* mission. The problems experienced are noted in Table 4. The many transmitter problems are being investigated at this time.

B. DSS 14

Seven passes were tracked as shown in Table 5. The only schedule change occurred on February 4 when DSS 14 was requested to be on track earlier than the scheduled 03:00 GMT in order to observe the second Lunar Module checkout. This second checkout was to investigate the Lunar Module battery problem, and it was thought that low power levels might have resulted in a degraded telemetry signal. Accordingly, DSS 14 was tracking at 00:43 GMT on February 4. DSS 14 experienced no problems that had any effect on *Apollo 14* support.

C. DSS 62

DSS 62 tracked the Command/Service Module as planned on February 4 from 13:32:18 to 22:12:47 GMT. The required doppler data was successfully taken and sent to JPL.

D. Predict Operations

It is apparent that the extraordinary care given to predict generation problem before the mission paid off, because no problems were experienced during the mission (unusual for *Apollo*). The personnel were eagerly cooperative, and it is felt that this spirit is responsible for maintaining and operating the system with so many known weak points.

The 29-point acquisition messages were also used on occasion at DSS 14. Several comparisons were made between the two types of predicts with no significant discrepancies except for the Lunar Module powered descent. This difference was anticipated since the 7094 predict program cannot model a long duration burn with a changing force vector. Thus, the 29-point message was much more accurate and was used for powered descent.

E. SFOF Participation

The SFOF areas and equipment used for *Apollo 14* included the Operations Area, the Network Analysis Area, the displays, the relocated 7094, and the Media Conver-

Table 4. Wing station tracking

DSS	GMT, h:min	Problem
11	Jan 31/22:31–22:34	None
	Jan 31/23:53–07:35	PA 4 (power amplifier) high-voltage rectifier interlock; no apparent reason. PA 3 arc detector trip; no apparent reason
	Feb 01/20:43–08:42	None
	Feb 02/21:10–09:02	Maser 1 exhaust valve frozen; will replace maser
	Feb 03/21:17–08:54	PA 3 arc detector trip at 22:24; switch to PA 4 after 19 seconds
	Feb 04/21:13–10:05	PA 4 high-voltage ac overcurrent trip; no apparent reason
	Feb 05/21:53–10:54	None
	Feb 07/00:01–11:21	None
	Feb 07/23:37–11:32	None
	Feb 08/23:30–12:06	PA 4 high-voltage ac overcurrent trip; no apparent reason; PA was in standby
42	Feb 01/04:45–12:25	Both klystron power supplies tripped on beam overvoltage; transmitters were not radiating
	Feb 02/05:31–13:18	None
	Feb 03/05:41–13:41	None
	Feb 04/05:42–13:57	None
	Feb 05/06:37–14:45	None
	Feb 06/07:33–15:47	None
	Feb 07/08:02–16:11	None
	Feb 08/08:06–16:29	None
	Feb 09/08:24–16:41	None
	Feb 09/17:08–18:48	None (ALSEP track)
	Feb 09/20:35–20:49	None
61	Feb 01/11:58–02:00	None
	Feb 02/12:33–02:17	None
	Feb 03/12:45–02:26	None
	Feb 04/13:32–03:07	None
	Feb 05/13:50–04:05	PA 2 excessive reflected power trip during pretrack; retuned klystron
	Feb 06/14:43–04:51	None
	Feb 07/15:10–04:54	None
	Feb 08/15:28–04:58	None
	Feb 09/17:56–19:25	None

Table 5. DSS 14 tracking

Date, Feb 1971	GMT, h:min:s
1	01:13:50–06:30:00
2	00:30:52–06:30:00
2	22:59:00–04:30:00
4	00:43:00–09:55:00
4	21:07:15–10:57:40
5	21:42:34–11:51:40
6	22:40:00–06:00:00

sion Center. The SFOF support is limited to predict generation and some off-line monitoring. As mentioned above, the support was excellent.

F. GCF Participation

The DSN GCF provided voice and teletype circuits as required to support the operations mentioned above. In addition, JPL acts as West Coast Switching Center for the NASA Communications Network and handles many non-DSN circuits in support of *Apollo*. The only known GCF problem was a bad set of communications processor log tapes covering parts of the precision doppler data collection. These data were later recovered from DSS 14 and 62 tracking data tapes were sent in by mail.

Reference

1. Hartley, R. B., "*Apollo* Mission Support," in *The Deep Space Network*, Space Programs Summary 37-64, Vol. II, pp. 7–11. Jet Propulsion Laboratory, Pasadena, Calif., Aug. 31, 1970.