Pioneer Mission Support

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A description of the planned configuration and data flow methodology of the Mark III Deep Space Network System is given. This system will support the Pioneer F and G missions and the successive projects of the NASA mission set of the 1970s. Block diagrams graphically illustrate the planned functions of the DSN Telemetry, Tracking, and Command Systems including their capabilities of being compatible with the forthcoming project requirements. The basic interfaces between subsystems of the three DSN facilities are defined.

I. Introduction

The description of the *Pioneer F* and *G* mission profile, the spacecraft with its major subsystems, the Conical Scanning System (CONSCAN), and the specific objectives of the scientific instruments was presented in previous issues of the DSN Progress Report (Refs. 1, 2, and 3). Special emphasis was given on the elaborations of mission characteristics which interface with the tracking and data acquisition functions.

This article provides a description of the ground-based equipment necessary to maintain a two-way telecommunications link with the spacecraft and obtain a precision two-way doppler frequency for radio metric data and orbit determination. The configuration, data flow, and interfaces of the Telemetry, Command, and Tracking Systems of the Mark III Deep Space Network are given.

II. Objectives of the DSN Mark III System

During the 1960 decade, the evolution of the tracking and data acquisition technology of deep space missions extended our human senses beyond all previous imagination. The DSN accommodated various flight project requirements in all areas to furnish the best data return for each mission. Because of changes in the state-of-the-art of deep space telecommunications, flight projects developed their own demodulation and command equipment during the sixties, and the stations of the DSN were constrained by the installation and operation of mission-dependent equipment at all deep space stations (DSSs). Since the network was configured specifically for each project, the standardization and efficient utilization of the network's resources were not possible.

After extensive experience in supporting more than 20 deep space missions within 10 years, the DSN came to the conclusion that if more than one project required an identical or similar functional capability, that function should be considered to be multiple-mission in nature and should be provided by the tracking and data system common to these projects. It was felt that economic considerations were paramount in deciding whether a specific function should be developed and implemented by a flight project or by the DSN. It was also understood that when a multiple-mission capability was implemented by the DSN, proper flexibility must be provided to accommodate specific project requirements; therefore, in such cases, the DSN provides a simple and easily controlled interface.

The DSN Mark I system, operating in L-band, supported the flight projects during the first half of the 1960 decade. During the second half, the DSN introduced the Mark II system, operating in the S-band frequency range. The Mark I and II systems were especially designed to meet the requirements of each particular flight project. A sizable number of mission-dependent equipments and resources were used, and the number of the project independent/dependent interfaces was extensive. The DSN Mark III system is configured in accordance with the latest state-of-the-art in systems management and systems engineering. The basic objective of the Mark III DSN is to provide effective and reliable tracking and data acquisition support for the more complex planetary and interplanetary space flight missions in the 1970 decade. The DSN Mark III system was designed to serve the mission set of the seventies, and it will have sufficient flexibility to meet specific project requirements.

The DSN Mark III system will provide the following functions:

(1) *Acquisition of spacecraft telemetry data using standardized techniques.* The network will operate at higher and more valuable telemetry rates, for longer periods of time, covering longer distances and supporting multiple spacecraft simultaneously. The capability will also exist to interact efficiently with larger and more complex spacecraft and science packages.

(2) *Positive control of spacecraft using standardized commanding techniques.* The new capabilities will accommodate higher command bit rates covering longer deep space distances when operating directly from the control center by the flight project mission operations team. The advanced command capabilities will make possible simultaneous control of multiple spacecraft and the control of a variety of spacecraft types and scientific experiments.

(3) *Highly accurate radio navigation from Earth-based stations.* The improved radio metric tracking system will furnish precise range and range rate data at longer distances and will make simultaneous tracking and guidance of multiple spacecraft possible. A more accurate orbit computation capability will permit the accommodation of more precise planetary ephemerides and astrodynamical constants.

(4) *Support of complex mission operations requirements.* It will be possible to operate independently and simultaneously multiple-flight missions with some mission support areas at remote locations. The real-time evaluation capability to monitor the network's qualitative and quantitative performance will be an assurance to minimize loss of data and permit the identification of ground versus spacecraft failures.

(5) *Simulation of complex space flight operations.* An extensive simulation capability will permit spacecraft and ground network failure mode testing for flight operations training, and can also be used as a diagnostic tool for ground network testing and fault isolation.

The DSN started the detailed system design of the Mark III system in 1968, and implementation of this third generation system started in 1969. The phase-over between the Mark II and Mark III systems is taking place during the calendar year 1971. The tracking and data acquisition support configuration of the *Mariner* 9 mission, which was launched in May 1971, represents the early version of the Mark III system. The network's configuration for the *Pioneer F* mission, to be launched in the latter part of February 1972, will resemble the major features of the Mark III system.

Figure 1 depicts the functional relationship between the six DSN systems and the three DSN facilities. The Tracking, Telemetry, and Command Systems perform the basic functions of the mission support. The Simulation, Monitoring, and Operations Control Systems are necessary to test the facilities, to train the operations teams, to monitor all DSN systems, and to control the operations of the DSN systems.

The DSN facilities can be grouped in three categories: (1) the Deep Space Instrumentation Facility (DSIF), with tracking stations located in California, Australia, Spain, and South Africa (Table 1); (2) the Ground Communications Facility (GCF), with a centrally located Control Center in the Space Flight Operations Facility (SFOF) located at JPL, Pasadena, California; and (3) the SFOF, which also houses the mission support areas, where the project's mission operations teams carry out the following system functions: project control, flight path analysis, spacecraft analysis, and space science analysis. All facilities have the capability within each DSN system to operate in a bidirectional mode.

A detailed description of the DSN Telemetry, Tracking, and Command Systems is given below. The configuration and data flow of each system is defined as planned to support the *Pioneer F* and *G* missions. Additional interfaces with the flight project between the DSN subsystems of each DSN facility and DSN system are also shown.

The block diagrams of the DSN systems illustrate graphically the planned functions of each DSN system. Each diagram, as viewed from left to right, is divided into the three DSN facilities: DSIF, GCF, and SFOF. Each facility is shown as a group of component subsystems connected with data flow paths.

III. DSN Telemetry System

The DSN Telemetry System is depicted in Fig. 2 and its equipment/subsystem and software capabilities are described in Tables 2 and 3, respectively. The figure describes the 26-m deep space stations configured to support the *Pioneer F* and *G* missions during their cruise phase. The basic telemetry system capabilities of the 64-m deep space stations are similar to the 26-m stations.

The DSN Telemetry System provides the capability for acquisition, conversion, handling, display, distribution, processing, and selection of telemetry data. Telemetry data are defined as the engineering and science information, including video, received from flight spacecraft via the telecommunications links.

The basic characteristics of the DSN Telemetry System will be as follows:

(1) Centralized control from the SFOF of the DSN Telemetry System configuration. This will include the automatic execution by the deep space stations of configuration and telemetry standards and limits messages compiled by the DSN Telemetry Analysis Group, centrally located in the SFOF.

(2) Real-time reporting of DSN Telemetry System status to DSN Operations Control with digital television (DTV) displays through the Monitor System.

(3) Ability to handle a wide range of spacecraft data rates while simultaneously supporting multiple-project and multiple-data streams.

(4) Capability in the SFOF to process data in real time from one or more deep space stations and missions simultaneously without interference. There will be a capability to support missions in both test and flight operations phases.

(5) Capability at each deep space station for subcarrier demodulation, bit detection, and data decoding; preparation of a digital Original Data Record (ODR); and formatting for a high-speed transmission to the SFOF.

IV. DSN Command System

The DSN Command System is shown in Fig. 3 and its equipment/subsystem capabilities are given in Table 4. The DSN Command System provides the means to generate and transmit commands to appropriate spacecraft-related verification, display, and control functions which are incorporated within the system to ensure that these command operations are successful. The DSN Command System provides a project with the means to command the spacecraft from the SFOF. The project may enter commands by input/output (I/O) devices in the SFOF, or by high-speed data (HSD) lines into SFOF from a remote location.

V. DSN Tracking System

A functional block diagram showing the DSN Tracking System configured for 26-m stations is given in Fig. 4 and that for 64-m stations is given in Fig. 5. Equipment/subsystem capabilities for each are described in Tables 5 and 6, respectively.

The DSN Tracking System provides validated, precision radio metric data to flight project users by performing the tasks of data acquisition, handling, editing, calibration, display, distribution, validation, and prediction. In addition, a tracking data selection process is made available to the project users.

DSN metric data are defined as angle and doppler data generated by the DSIF and associated data such as lock status, time, frequency, data condition, and calibration. Detailed interface design is contained in Ref. 5.

The key characteristics of the DSN Tracking System are as follows:

(1) Processing of DSN metric data in any standard DSN Tracking System format.

(2) Multimission capability to perform:

(a) Simultaneous tracking and data acquisition of several spacecraft within the DSIF by the use of multiple DSSs.

(b) Data handling at DSSs and transmission of data to the SFOF.

References

1. Siegmeth, A. J., "*Pioneer* Mission Support," in *The Deep Space Network Progress Report,* Technical Report 32-1526, Vol. II, pp. 6–17. Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1971.

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4. *DSN Standard Practice, DSN/Flight Project Interface Design Handbook,* Document 810-5, Rev. A, Change 3, Aug. 1971 (JPL internal document).

5. *Deep Space Network System Requirements, Detailed Interface Design,* Document 820-13, Rev. A, Change 11, Aug. 1971 (JPL internal document).

Table 1. Deep Space Instrumentation Facilities

Deep Space Station	Location	Subnet	*Pioneer F and G* support function
DSS 11	Goldstone, California	26-m antennas	Cruise
DSS 12	Goldstone, California	26-m antenna	Cruise
DSS 14	Goldstone, California	64-m antenna	Mission enhancement and Jupiter encounter
DSS 41	Woomera, Australia	26-m antenna	Cruise
DSS 42	Weemala, Australia	26-m antenna	Cruise
DSS 51	Johannesburg, South Africa	26-m antenna	Launch and cruise
DSS 61	Robledo, Spain	26-m antenna	Cruise
DSS 62	Cebreros, Spain	26-m antenna	Cruise
DSS 71	Cape Kennedy, Florida		Spacecraft/DSN compatibility verification
CTA 21	JPL, Pasadena, California		Spacecraft/DSN compatibility testing
DSS 43[a]	Ballima, Australia	64-m antenna	Mission enhancement and Jupiter encounter
DSS 63[a]	Robledo, Spain	64-m antenna	Mission enhancement and Jupiter encounter

[a]After July 1973.

Table 2. DSN Telemetry System equipment/subsystem capabilities for 26-m stations (Fig. 2)

(A) Output time to tag ground receiver data to 1 ms.

(B) System temperature as described in Ref. 4.

(C) The High-Speed Data Assembly receives data from different DSIF systems. Priorities must be assigned by the Project/DSN for transmission of data to the SFOF.

Table 3. DSN Telemetry System software capabilities for 26-m stations (Fig. 2)

(a) DSIF Telemetry and Command Subsystem

a. *Input processing*

(1) Accept one bit stream of combined engineering and science telemetry data varying between 16 and 2048 bps uncoded, or between 32 and 4096 sps coded.

(2) Also accept associated input messages:

(a) Ground receiver automatic gain control (AGC).

(b) Time reference.

(c) Hardware lock status.

(d) Operator message through the computer console.

(e) Nonreal-time playback from digital and post-SDA analog records.

b. *Internal processing*

(1) Control bit synchronization and detection.

(2) Control decoding.

(3) Calculate signal-to-noise ratio (SNR) and ground AGC in dB.

c. *Output processing*

(1) Format and output for transmission to the SFOF via HSD circuits.

(2) Subsystem status to Monitor System.

(3) Data to digital ODR.

(b) Central Processing System—360/75

a. *Input processing*

(1) Accept data simultaneously from up to three HSD circuits, separate telemetry and partial status data, route data for internal processing, input process log tapes, and route telemetry HSD messages to Ames Research Center (ARC).

(2) Frame synchronization, pseudo-noise sync error calculation.

(3) Telemetry validation and selection on the basis of TCP signal-to-noise, GCF error, timing, and frame sync quality.

(4) Alarm limits, range suppression, suppression tolerances, data number to engineering unit conversion, data averaging, logic tests, continuity tests.

(5) Interface with SFOF Internal Communications Subsystem, drive hard copy, and volatile displays.

b. *Internal processing*

(1) Decommutate, and format telemetry data streams.

(2) Process and analyze DSN status and alarm data.

(3) Compare DSN standards (SNR ground AGC, frame sync quality) to predicts.

(4) Generate system log tapes, SDR and MDR files.

c. *Output processing*

(1) Hard copy and volatile display data to UTDS.

(2) Master Data Record (MDR) tapes.

(3) DSN status and alarms to Telemetry Analysis Group, Monitor System, and Mission Support Area (MSA).

(4) System configuration and replay request messages to the DSIF.

(5) Telemetry data to Remote Information Center via HSDL.

(6) Data to the 1108.

Table 4. DSN Command System equipment/subsystem capabilities for 26- and 64-m stations (Fig. 3)

Ⓐ DSS 14 will have capability for redundant exciters and dual carriers. All other stations shall have a single exciter and single carrier capability.

DSS 14 will have capability to transmit at 400 kW; the 26-m subnet stations will have 10-kW transmit capability; the 26-m mutual stations will have 20-kW transmit capability.

Ⓑ SDS 920 telemetry and command processor program capabilities for command: The following functions shall be available for one spacecraft, sharing the TCP with Telemetry System programs that are not to exceed 2 kbps uncoded.

a. Input processing

(1) HSD command, configuration, standards and limits, recall request, disable messages SFOF.

(2) Command messages, enables/disables, and recall messages via local DSS manual input (backup).

b. Output processing

(1) Output process and format, for HSD transmission, the following data:

(a) HSD verify messages to inform the SFOF that command HSD messages were received by the 920 with or without errors.

(b) Command recall response messages to inform the SFOF of either:

(i) The status of equipment and software of the multimission command system.

(ii) The current command messages stored within the TCP, but not yet processed.

(c) *Confirm/abort* messages to inform the SFOF that proper command was either transmitted by the DSS, or that an abort occurred while in process of transmitting. Transmitted bits are identified.

(2) Output process and format, for transmission to Digital Instrumentation Subsystem (DIS) computer, via 24-bit parallel register, the following types of monitor data:

(a) All hardware status indicator information from multimission command hardware.

(b) Error indication if bit-by-bit comparison between CMA and TCP shows difference.

(c) Error indicator when received HSD command message or request message blocks indicate HSD error.

(3) Output process and format teletype messages to SMC for local display containing such information as:

(a) Indication of *command* message or *enable/disable* received.

(b) Indication of command *request/response* messages.

(c) Command *confirm/abort* messages.

(d) Indication of command verification message sent.

(4) Output process and format digital magnetic log tape ODR containing all received commands, *enable/disable* messages, command instructions, command confirmation/abort (data combined on tape with telemetry data for the ODR).

(5) Transmit command bits to CMA.

Table 4 (contd)

c. Internal processing

(1) Extract spacecraft number from command instruction message and use to obtain parameters with which to initialize multimission command hardware.

(2) Keep time against computer clock reference until stored command is to be processed and sent to the CMA.

(3) Extract required parameters from command instruction message; buffer and store for recall response.

(4) If the command has been *enabled*, transmit command at time given in command message, or immediately, if specified.

(5) Perform verification on command message received over HSD (GCF error detection) and prepare verification message.

(6) Compare data in command instruction message and generate alarm if system is out of tolerance.

(7) If a command is *disabled*, remove it from storage; if command is in process, inhibit transmission of remaining bits.

Ⓒ Located at the station manager's console.

Ⓓ Not used.

Ⓔ The CMD Message Accountability Processor provides automatic interrogation of the DSSs as to status of the commands sent from the SFOF to the DSSs, and provides a continuous accounting of all commands entered into the DSN Command System at the SFOF.

Ⓕ The HSD Message Block Output Processor formats, buffers, and transmits command messages to the appropriate DSS. If no verified response is received, the message is repeated. The time between repeats and the number of repeats before an alarm is raised are controllable.

Ⓖ The HSD Block Return Processor handles verification, alarm, and abort messages received via HSD from DSSs and generates appropriate displays of status and alarms. The data are also presented to the SDR Processor.

Ⓗ The Message Construct Program performs the following functions:

(1) Accepts project generated command messages and prepares them for HSD transmission.

(2) Accepts control messages for command processing and display.

(3) Accepts configuration, standards and limits, and test command messages from Command Analysis Group.

(4) Accepts project generated *enable/disable* messages and transmits to DSS; rejects *enable* if the command message has not yet been verified.

(5) Accepts command recall request messages and prepares for transmission or interrogates CPS buffer and displays command recall response messages.

(6) Compares commands input against critical command table and stops further processing of command until interlock is input from 2260 to release inhibit.

(7) Translates alphanumeric input into binary bit stream for input to the HSD blocks.

Ⓘ The SDR Processor logs and verifies all SFOF–DSS HSD Command System traffic.

Ⓙ The MDR Processor extracts the *confirm* and *abort* message data from the SDR files, generates summaries and labels for the MDR, and writes the MDR data on file or tape.

Table 5. DSN Tracking System equipment/subsystem capabilities for 26-m stations (Fig. 4)

(A) Not used for *Pioneer* Project.

(B) The Tracking Data Processor samples and formats Greenwich Mean Time, doppler, range, angles, and partial status for transmission (10) to the Antenna Pointing Subsystem (prime) and/or via TTY (16) to the GCF Comm Processor (N). The reperforated TTY tape is maintained as the low-rate ODR (11) (rates 1 per 6 s).

(C) The Antenna Pointing Subsystem receives metric data from the TDP (10). The metric data is reformatted to conform to standard National Aeronautics and Space Administration Communications Network (NASCOM) HSD block format and is transmitted via HSD (17) to the SFOF. The APS punches a tape for the DSIF ODR (12) for rates of 1 per 6 s. The APS also receives predictions via HSD (31) or TTY (34) (torn paper tape), interpolates these predictions to 1 per second, and provides interpolated angles to the Antenna Pointing Programmer (APP) (14). DSIF tracking system partial status is transmitted to the DIS via a 24-bit parallel transfer register (13).

(D) The APP receives 1-per-second predicted angular positions from APS and further interpolates these angles to 50 per second; it compares the 50-per-second predictions with the antenna angle readout (9) and generates an error signal to the Antenna Servo Subsystem (15). The Antenna Servo Subsystem then drives the antenna to null this error signal.

(E) The Digital Instrumentation Subsystem receives the tracking system partial status via the 24-bit parallel transfer register for display to DSS operational control. Predictions are transmitted from the SFOF to the DSS via HSDL (31) and are formatted and displayed (32) to DSS operational control for spacecraft acquisition.

(F) The SFOF Tracking Data Input Processor provides a data format identification, decommutation, data conversion, and reformatting and displays input data. It also provides a capability of the derivation of the sample rate, line outage detection, and alarm classification.

(G) The Pseudo-Residual Processor computes the difference between observables and predictions, identifies blunder points, computes data "noise" and provides a data quality index to the Master File Program (MFP) that is added to the SDR.

Table 5 (contd)

(H) The MFP creates an SDR on disk or tape, provides a capability of rejecting data, provides a data accountability function, edits tracking data, tags the SDR with the quality indicator computed in (G), transfers data to the 1108 through the Project Data Selector (J) (18), and provides a display capability.

(I) The SDR Accountability Program computes the percentage of data received "good" as compared with the scheduled data availability.

(J) The Project Data Selector Program provides a capability to a project for the data selection (18) based on spacecraft, station, data type, and sample rate. The selected data is transferred to the project by tape or the electrical interface. The data selection program is also used to provide a magnetic tape (18) by spacecraft identifier for the DSN Master Data Record.

(K) The Tracking System Analytical Calibration (TSAC) Program computes calibrations for time and polar motion variations, transfers station locations, calibrates data for charged particles, and calibrates data for tropospheric corrections. These calibrations are made available to the project via the TSAC SDR (19) and Project Data Selector (J).

(L) The Predict Program computes DSS observables from a project-supplied spacecraft ephemeris (28). Also computed are DSS view periods and spacecraft events, such as occultation.

(M) The Operations Control Software formats and transmits to the DSS, via HSDL (31) or TTY (30) (dependent on availability), the validated predictions that were transferred to the Prediction File (29).

(N) Communications Processor which routes TTY data.

(O) The Orbit Data Editor (ODE) Program accepts data from the Project Data Selector (J). This data is edited, calibrated, and formatted for inclusion on the master file of DPODP (P).

(P) The Double Precision Orbit Determination Program accepts data from the Orbit Data Editor (O) and determines a "best" state vector for the observables.

(Q) The Trajectory Program (DPTRAJ) provides a spacecraft ephemeris tape based on DPODP (26) solution, or a state vector provided by other sources (27). This spacecraft ephemeris is transferred to the 360/75 via tape or the electrical interface (28).

Table 6. DSN Tracking System equipment/subsystem capabilities for 64-m stations (Fig. 5)

(A) The DSIF Tracking Subsystem (DTS), a single multipurpose computer, performs the following functions: tracking data formatting, planetary ranging, error detection, predict generation, and antenna pointing.

(B) The ranging function of the DTS provides ranging information at planetary distances (not used by *Pioneer* Project).

(C) The Tracking Data Processor (TDP) function of the DTS samples and formats GMT, doppler, range, angles, errors, and partial status for transmission via HSD (17) to the SFOF. The TDP also generates onsite tracking data predictions for station use and for antenna pointing operations (14). Detected alarms are provided the Digital Instrumentation Subsystem (13). The DTS also receives predictions and control messages via HSDL (34) from the SFOF.

(D) The antenna pointing function of the DTS receives information from the TDP, compares with predictions of antenna angles, and generates an error signal to the Antenna Servo Subsystem (15).

(E) The Digital Instrumentation Subsystem receives partial status and error alarms from the TDP (13) for monitor and operational control. The DIS also receives predicts via HSDL (31) from the SFOF and outputs page prints of the predicts (32) for station spacecraft acquisition operations.

(F) The SFOF Tracking Data Input Processor (TYDIP) provides a data format identification, decommutation, data conversion and reformatting, and displays input data. It also provides a capability of the derivation of the sample rate, line outage detection, and alarm classification.

(G) The Pseudo-Residual Processor computes the difference between observables and predictions, identifies blunder points, computes data "noise" and provides a data quality index that is added to the SDR.

(H) The Master File Program (MFP) creates an SDR on disk or tape, provides a capability of rejecting data, provides a data accountability function, edits radio metric data, tags SDR with the quality indicator computed in Pseudo-Residual Program (G), transfers data to the 1108, and provides a display capability.

Table 6 (contd)

(I) The System Data Record accountability program computes the percentage of data received "good" as compared with the scheduled data availability.

(J) The Project Data Selector Program provides a capability to a project for the data selection (18) based on spacecraft, station, data type, and sample rate. The selected data is transferred to the project by tape or electrical interface. The data selection program is also used to provide a magnetic tape (18) by spacecraft identifier for the DSN Master Data Record.

(K) The Tracking System Analytical Calibration (TSAC) Program computes calibrations for time and polar motion variations, transfers station locations, calibrates data for charged particles and calibrates data for tropospheric corrections. These calibrations are made available to the project via the TSAC SDR (19).

(L) The Predict Program computes DSS observables from a project-supplied spacecraft probe ephemeris (28). Also computed are DSS view periods and spacecraft events, such as occultation (29).

(M) The DSN Operations Control software accepts the validated predicts from the prediction files and formats and transmits the predicts to the DSS via HSDL (31) or teletype (30), dependent on availability.

(O) The Orbit Data Editor accepts data from the Project Data Selector (18), which is edited, calibrated, and formatted for inclusion on the master file of DPODP (P).

(P) The Double Precision Orbit Determination Program accepts data from the Orbit Data Editor and determines a "best" state vector for the observables.

(Q) The Trajectory Program (DPTRAJ) provides a spacecraft ephemeris tape based on DPODP solution or a state vector provided by other sources (27). This spacecraft probe ephemeris is transferred to the 360/75 via tape or the electrical interface (28).

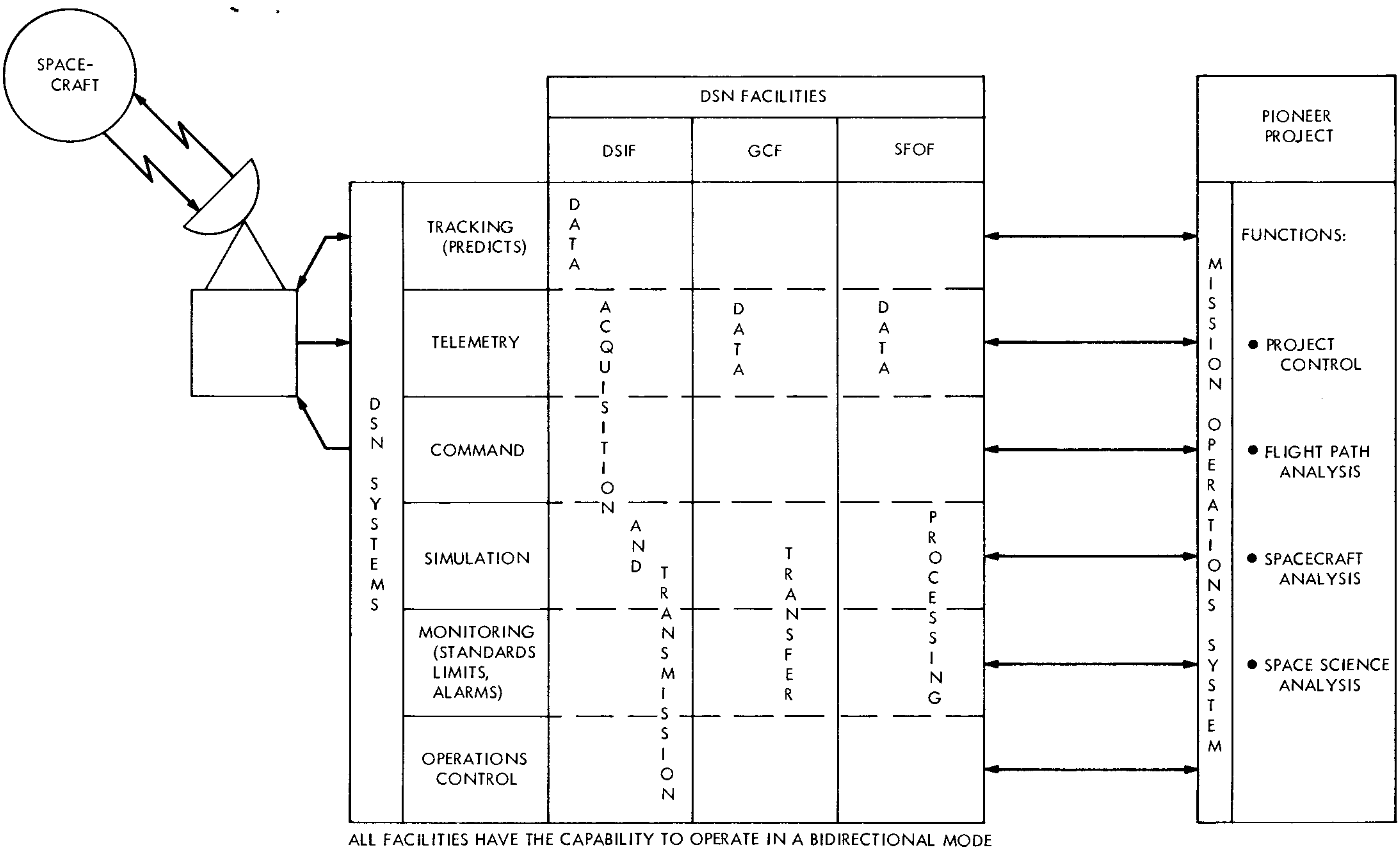
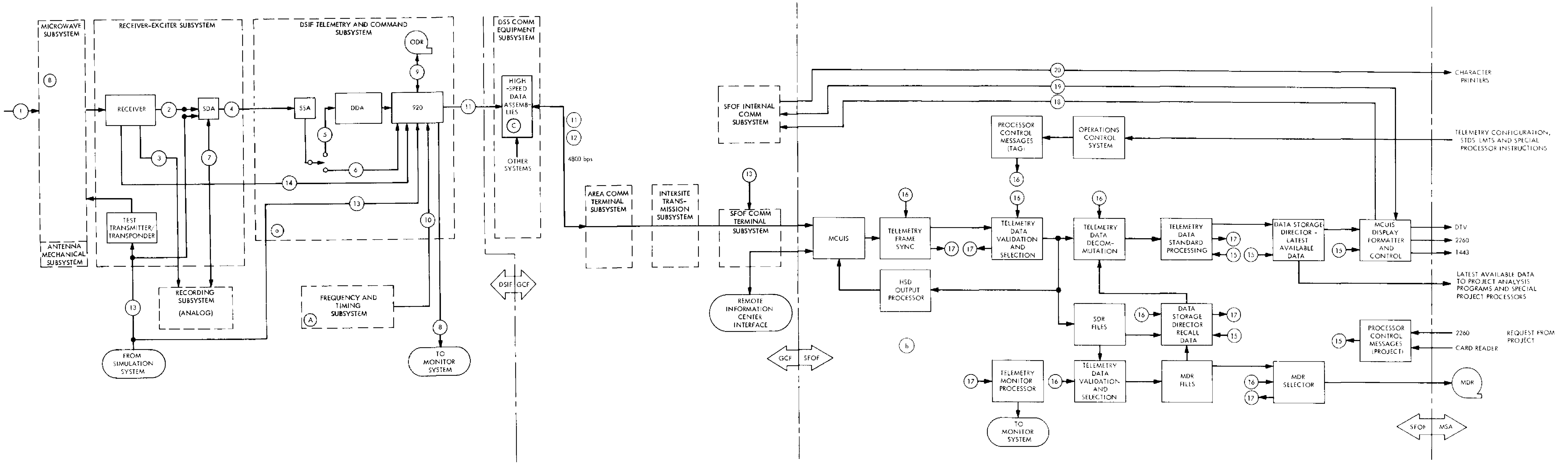


Fig. 1. Deep Space Network Systems



(1) CARRIER FROM ONE SPACECRAFT

(2) 32.768-kHz SUBCARRIER PHASE-MODULATED ON 10-MHz CARRIER

(3) 32.768-kHz SUBCARRIER WITH TELEMETRY DATA (NO PLAYBACK CAPABILITY)

(4) DATA STREAM 16-2048 bps UNCODED OR 32-4096 sps CODED

(5) CODED DATA

(6) UNCODED DATA

(7) SUBCARRIER DEMODULATOR ASSEMBLY (SDA) OUTPUT AND PLAYBACK OF RECORDED SDA OUTPUT

(8) INITIAL CONFIGURATION AND EVENT, TELEMETRY INSTRUMENTATION STATUS

(9) DIGITAL ODR RECORDING AND PLAYBACK (DELETED, CODED FRAMES WILL BE PLAYED BACK THROUGH THE DDA FOR REPLAYED DATA)

(10) TIME FOR GROUND DATA TAGGING

(11) TELEMETRY DATA TO SFOF VIA HIGH-SPEED DATA LINE, INCLUDES:
(a) ENGINEERING AND SCIENCE DATA AT 2048 bps MAXIMUM,
(b) REPLAY OF ODR NOT SIMULTANEOUS WITH (a), AND (c) DSS TELEMETRY SYSTEM PARTIAL STATUS (SNR, LOCK, AND CONFIGURATION INDICATORS) AND SUPPLEMENTARY DATA (GROUND ACG AT 10 samples/s MAXIMUM)

(12) CONFIGURATION AND REPLAY REQUEST MESSAGES FROM THE SFOF TO THE DSIF VIA HSDL

(13) SIMULATED TELEMETRY INPUTS

(14) GROUND RECEIVER AGC

(15) CONTROL FOR TELEMETRY DATA PROCESSING BY THE PROJECT FROM USER TERMINAL AND DISPLAY SUBSYSTEM (UTDS)

(16) CONTROL FOR TELEMETRY MDR PROCESSING BY DSN TELEMETRY ANALYSIS GROUP FROM UTDS

(17) DSN TELEMETRY SYSTEM INSTRUMENTATION STATUS AND SELECTED DECOMMUTATED SPACECRAFT PARAMETERS FOR MONITOR DISPLAY

(18) CONTROL TO SFOF INTERNAL COMM SUBSYSTEM FOR DIGITAL TV

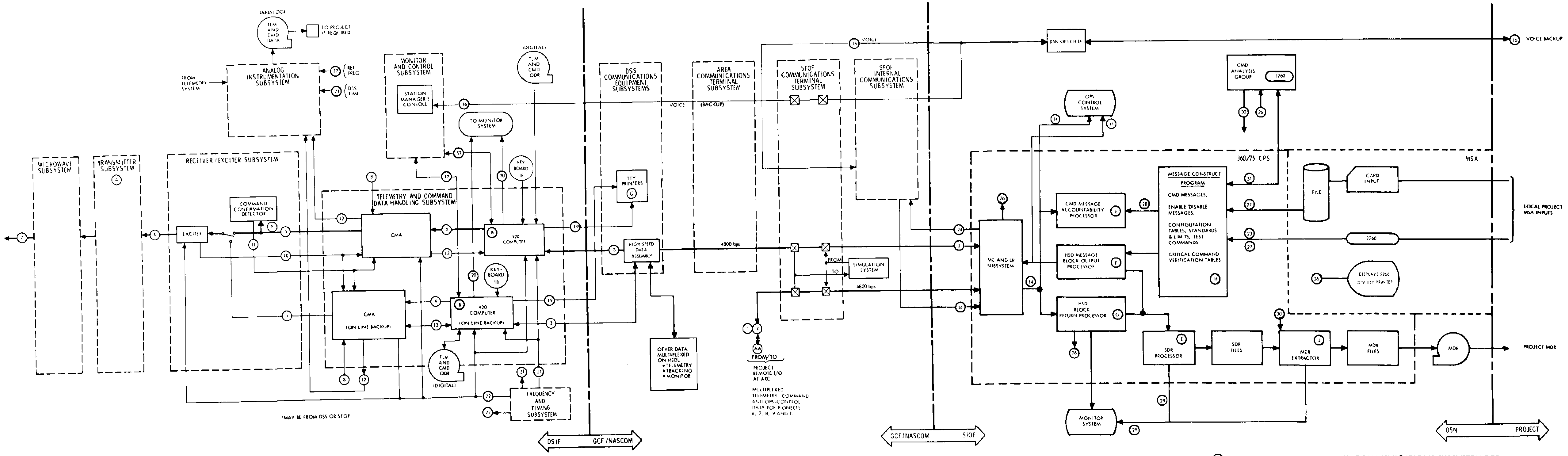
(19) DIGITAL TV SIGNALS FOR DISPLAY

(20) 360/75 CHARACTER PRINTER OUTPUT FROM COMMUNICATIONS PROCESSOR

(A) TO (C) DEFINED IN TABLE 2

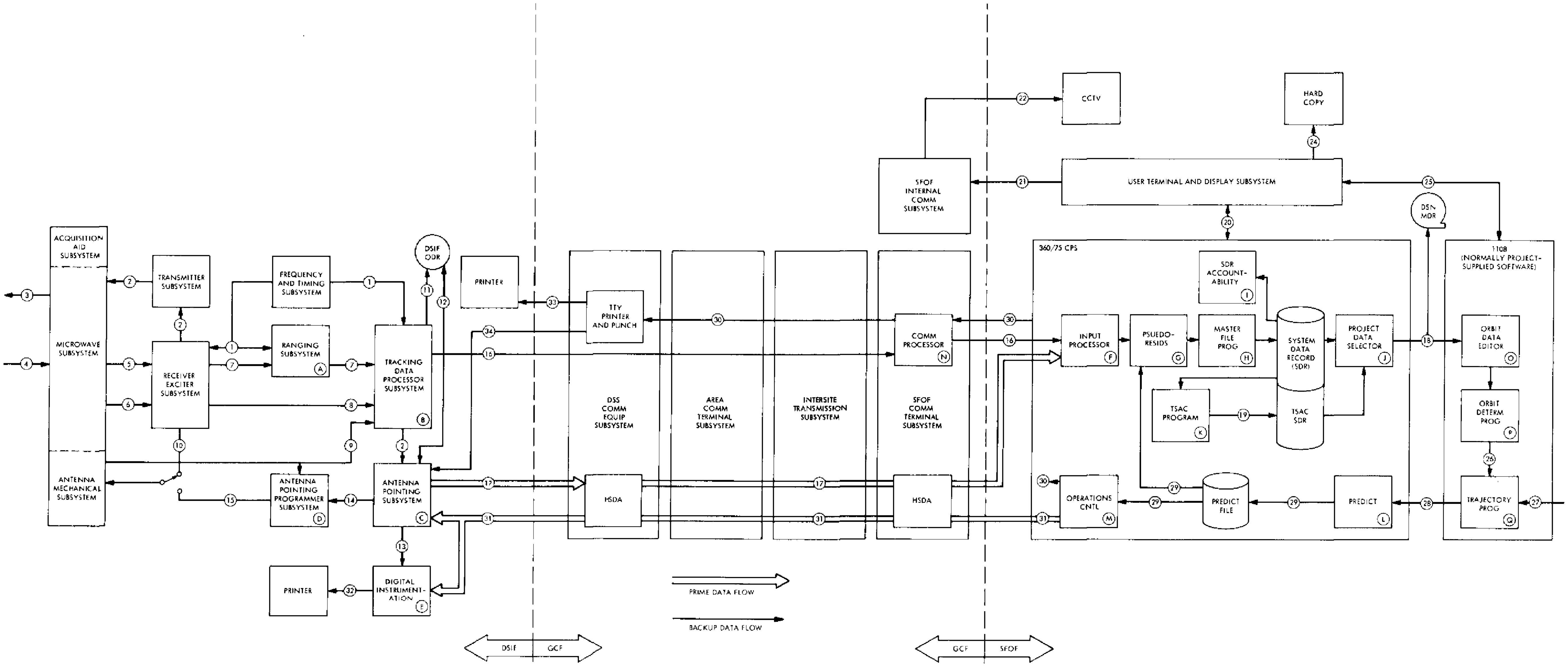
(a) TO (b) DEFINED IN TABLE 3

Fig. 2. DSN Telemetry System 26-m DSS functional block diagram for *Pioneer F* and *G* cruise mode configuration



(1) COMMAND MESSAGE OUTPUTS FROM REMOTE MSA TO SFOF
(2) SFOF-PROCESSED COMMAND INFORMATION RESPONDING TO (1) AND PROVIDING INFORMATION FOR REMOTE MSA DISPLAYS
(3) COMMAND MESSAGES, COMMAND INSTRUCTION MESSAGES, AND COMMAND RECALL REQUEST MESSAGES TO DSS; COMMAND VERIFICATION, CONFIRM/ABORT, ALARM, AND RECALL RESPONSE MESSAGES TO SFOF
(4) COMMAND WORD BITS
(5) COMMAND MODULATED SUBCARRIER
(6) TRANSMITTER DRIVE
(7) AMPLIFIED, MODULATED S-BAND UPLINK CARRIER
(8) TRANSMITTER, EXCITER, AND MODULATOR, ON OR OFF INDICATION
(9) MODULATOR OUTPUT FOR COMMAND CONFIRMATION
(10) EXCITER FREQUENCY
(11) DETECTED MODULATOR OUTPUT, ITEM (9) FOR ABORT OR CONFIRMATION
(12) COMMAND MODULATION ASSEMBLY OUTPUT FOR RECORDING ON ANALOG TAPE
(13) CONTROL INFORMATION, COMMAND BITS, AND CONFIGURATION INFORMATION FED BACK TO THE COMPUTER
(14) COMMAND SYSTEM MESSAGES SENT FROM DSS TO SFOF
(15) COMMAND MESSAGES TO BE USED BY OPERATIONS CONTROL SYSTEM TO LIST EXPECTED DSN CONFIGURATION CHANGES RESULTING FROM COMMANDS TRANSMITTED
(16) VOICE CIRCUITS FOR EMERGENCY MODE COMMAND COORDINATION
(17) MANUAL MODE ENABLE AND DISPLAY CONTROL SIGNALS
(18) MANUAL MODE COMMAND INPUT, ENABLED BY STATION MANAGER
(19) COMMANDS, VERIFICATION, CONFIRMATION, ABORT, AND ALARM INFORMATION FOR LOCAL DISPLAY AT DSS
(20) COMMAND SYSTEM CONFIGURATION, STATUS, AND ALARMS
(21) DSS TIME
(22) REFERENCE FREQUENCIES
(23) CONTROL MESSAGES FOR COMMAND PROCESSING AND DISPLAY, RECALL RESPONSE MESSAGES, AND DATA DISPLAY
(24) CONTROL TO SFOF INTERNAL COMMUNICATIONS SUBSYSTEM FOR CHARACTER PRINTER AND CLOSED-CIRCUIT TELEVISION (CCTV) DISPLAY
(25) NOT USED
(26) DATA FOR CHARACTER PRINTER, CCTV DISPLAY, DTV DISPLAYS, AND HIGH-SPEED PRINTERS
(27) COMMAND MESSAGE INPUTS
(28) COMMAND MESSAGES FOR ACCOUNTABILITY PROCESSOR
(29) DATA SUMMARIES AND ALARMS
(30) INPUTS, RECALL REQUESTS TO MDR PROCESSOR FROM COMMAND ANALYSIS GROUP
(31) CONFIGURATION, STANDARDS AND LIMITS, TEST COMMANDS, RECALL REQUEST INPUTS
(A) TO (J) DEFINED IN TABLE 4

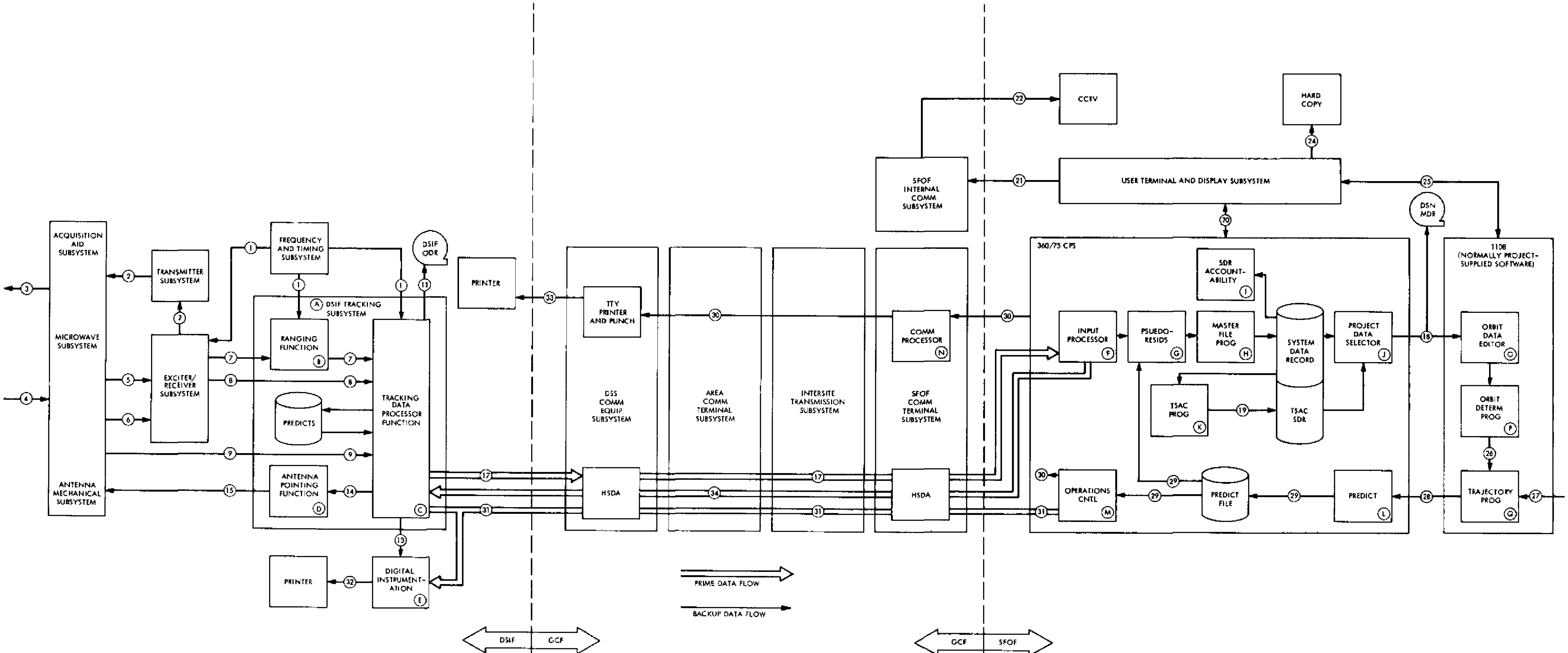
Fig. 3. DSN Command System 26- and 64-m DSS functional block diagram for Pioneer F and G cruise mode configuration



1 REFERENCE FREQUENCY/TIME
2 TRANSMITTER DRIVE
3 AMPLIFIED, MODULATED S-BAND CARRIER
4 S-BAND DOWNLINK
5 RECEIVER 1 INPUT
6 RECEIVER 2 INPUT
7 RANGE DATA AND RANGE PARTIAL STATUS (NOT USED BY PIONEER PROJECT)
8 DOPPLER DATA, TRANSMITTER VCO FREQUENCY, AND DOPPLER PARTIAL STATUS
9 ANGLE DATA AND ANGLE PARTIAL STATUS
10 AUTOTRACK FEEDBACK
11 LOW-RATE ODR (RATES EQUAL TO OR LESS THAN 1 PER 6 s)
12 HIGH-RATE ODR (RATES GREATER THAN 1 PER 6 s)
13 TRACKING SYSTEM PARTIAL STATUS TO MONITOR
14 ANGLE PREDICTIONS INTERPOLATED TO 1 PER SECOND
15 ANTENNA SERVO-DRIVE SIGNALS
16 LOW-RATE FORMATTED METRIC DATA VIA TTY (BACKUP)
17 LOW- AND HIGH-RATE FORMATTED METRIC DATA VIA HSD (PRIME)
18 METRIC DATA FROM SYSTEM DATA RECORD TO PROJECT AND DSN MDR
19 CALIBRATIONS FOR METRIC DATA
20 SFOF TRACKING SYSTEM I/O INSTRUCTIONS
21 DATA AND STATUS FOR DISPLAY VIA CCTV
22 CCTV DISPLAYS OF 21
23 NOT USED
24 HARD COPY DISPLAY OF REQUESTED DATA
25 PROJECT I/O INSTRUCTIONS TO ORBIT SOFTWARE
26 STATE VECTOR FROM DOUBLE PRECISION ORBIT DETERMINATION PROGRAM
27 STATE VECTOR FROM EXTERNAL SOURCE
28 SPACECRAFT EPHEMERIS
29 DSS PREDICTED OBSERVABLES
30 DSS PREDICTIONS TRANSMITTED VIA TTY BY OPERATIONS CONTROL SOFTWARE
31 DSS PREDICTIONS TRANSMITTED VIA HSDL BY OPERATIONS CONTROL SOFTWARE
32 PAGE PRINT OF 31 FOR DSS ACQUISITION OF SPACECRAFT (PRIME)
33 PAGE PRINT OF 30 FOR DSS ACQUISITION OF SPACECRAFT (BACKUP)
34 PAPER TAPE OF PREDICTIONS FOR ANTENNA POINTING SUBSYSTEM (BACKUP)

A TO Q DEFINED IN TABLE 5

Fig. 4. DSN Tracking System 26-m DSS functional block diagram for *Pioneer F* and *G* cruise mode configuration



1. REFERENCE FREQUENCY/TIME
2. TRANSMITTER DRIVE
3. AMPLIFIED, MODULATED S-BAND CARRIER
4. S-BAND DOWNLINK
5. RECEIVER 1 INPUT
6. RECEIVER 2 INPUT
7. RANGE DATA AND RANGE PARTIAL STATUS (NOT USED BY PIONEER PROJECT)
8. DOPPLER DATA, TRANSMITTER VCO FREQUENCY, AND DOPPLER PARTIAL STATUS
9. ANGLE DATA AND ANGLE PARTIAL STATUS
10. NOT USED
11. DSIF ODR
12. NOT USED
13. TRACKING SYSTEM PARTIAL STATUS TO MONITOR
14. ANGLE PREDICTIONS
15. ANTENNA SERVO-DRIVE SIGNALS
16. NOT USED
17. FORMATTED METRIC DATA VIA HSDA
18. METRIC DATA FROM SDR TO PROJECT AND DSN MDR
19. CALIBRATIONS FOR METRIC DATA
20. I/O INSTRUCTIONS TO SFOF TRACKING SOFTWARE
21. DATA AND STATUS FOR DISPLAY ON CCTV
22. CCTV DISPLAYS OF 21
23. NOT USED
24. HARD COPY DISPLAY OF REQUESTED DATA
25. PROJECT I/O INSTRUCTIONS TO ORBIT SOFTWARE
26. STATE VECTOR FROM DPODP
27. STATE VECTOR FROM EXTERNAL SOURCE
28. SPACECRAFT EPHEMERIS
29. DSS PREDICTED OBSERVABLES
30. DSS PREDICTIONS TRANSMITTED VIA TTY BY OPERATIONS CONTROL SOFTWARE
31. DSS PREDICTIONS TRANSMITTED VIA HSDL BY OPERATIONS CONTROL SOFTWARE
32. PAGE PRINT OF 31 FOR DSS ACQUISITION OF SPACECRAFT (PRIME)
33. PAGE PRINT OF 30 FOR DSS ACQUISITION OF SPACECRAFT (BACKUP)
34. PAPER TAPE OF PREDICTIONS FOR ANTENNA POINTING SUBSYSTEM (BACKUP)

A TO Q DEFINED IN TABLE 6

Fig. 5. DSN Tracking System 64-m DSS functional block diagram for *Pioneer F* and *G* cruise mode configuration