

DSN Ground Communications Facility

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A functional description of the GCF and its relationships with other elements of the DSN and NASCOM is presented together with development objectives and goals and comments on implementation activities in support of flight projects.

I. Introduction

The Ground Communications Facility (GCF) is one of the three elements of the DSN. The GCF provides for transmission, reception, and monitoring of Earth-based point-to-point communications between the Deep Space Stations (DSSs, one of the DSN elements), the Network Operations Control Center (NOCC, the other element) located at JPL, Pasadena, and the Mission Operations Control Center (MOC) at JPL. Voice, teletype, high-speed data, and wideband data circuits of the worldwide NASA Communications Network (NASCOM) are utilized for all long-distance circuits, except those between JPL and the Goldstone Deep Space Communications Complex (GDSCC). Goddard Space Flight Center (GSFC) NASCOM Engineering has delegated the responsibilities for planning, budgeting, design, implementation, operation, and maintenance of the communications requirements between Goldstone and JPL to the DSN GCF. Additionally, the GCF provides communications services between the DSSs at each geographic communications complex (Madrid, Australia and Goldstone, Calif.) via intersite microwave systems and between separated areas of the NOCC at JPL via 230 kbit/s wideband data channels. Also, voice communications are provided within the stations, between the stations, within the complexes, and within the NOCC. The GCF is comprised of seven subsystems; Voice, Teletype, High-Speed Data, Wideband Data, GCF Monitor

and Control, Data Records, and Network Communications Equipment. The DSN Telecommunications and Data Acquisition Engineering Office of JPL provides the technical direction and systems management of the GCF and acts as the representative of NASCOM for switching and interconnect functions on the west coast.

II. GCF-NASCOM Interrelationships

The interrelationships at the programmatic level between JPL's DSN GCF and the NASCOM network, which is managed, engineered, and controlled at GSFC, are characterized as follows:

NASCOM

- (1) Provides long-haul operational ground communications in support of all NASA projects and mission activities including those supported by the DSN.
- (2) Accepts and supports communications requirements established by the DSN and validated through continuing consultation and review.
- (3) Establishes in consultation with the users the basic characteristics of the NASCOM systems, such as tele-

type line rate and block header formats for switching, and the user electrical interfaces.

GCF

- (1) Provides ground communications for all DSN missions and uses the services of NASCOM.
- (2) Establishes additional characteristics of all GCF subsystems on an end-to-end basis such as block multiplexing, error correction, GCF monitoring and control, and data records capabilities.

III. Objectives and Goals

The primary objectives of the GCF are to provide highest quality point-to-point transfer of operational data within the DSN and provide simple user and NASCOM electrical and operational interfaces. These objectives are being met by:

- (1) Providing automatic message switching and routing.
- (2) Providing data transmission subsystems that are as transparent to the user as possible.
- (3) Minimizing project-dependent equipment within the GCF.
- (4) Providing a centralized common user data records capability.

The goals of the GCF are to provide highly reliable and cost-effective data transmission while continuing an adequate capability balance for multiple mission users. These goals include the following:

- (1) Equipment and routing redundancy to minimize single-point-of-failure impact.
- (2) End-to-end performance which provides essentially block-error-free throughput.
- (3) Design coordinated and consistent with the NASCOM Development Program.

IV. Configuration and Functional Subsystem

The current GCF configuration, including the related NASCOM interfaces and functions, is illustrated in Fig. 1. This configuration illustrates the long-haul communication circuit services external to JPL and Deep Space Communications Complexes (except circuits between the Goldstone Complex and JPL) which are the responsibility of NASCOM. The Voice, Teletype, High-Speed Data, Wideband Data, and GCF Monitor and Control Subsystems point-to-point communications are serviced by this Fig. 1 configuration.

A. High-Speed Data Subsystem

This subsystem shall consist of GCF assemblies that switch, transmit, record, process, distribute, test, and monitor digital data and is used for transmission of:

- (1) All digital data for the DSN Command, Tracking, and Monitor and Control Systems.
- (2) All low or medium rate data of the DSN Telemetry, Radio Science, Very Long Baseline Interferometry (VLBI), and the DSN Test Support System.

The High-Speed Data Subsystem provides a capability for transmitting and receiving the serial bit stream block formatted data over a properly conditioned full duplex alternate voice/data channel having a 3.0-kHz bandwidth or over time division multiplexed 56 kb/s satellite circuit. This serial bit stream is impressed on communication circuits at a continuous line bit rate divided into message segments referred to as high-speed data blocks.

Two types of data blocks are used:

- (1) Data blocks containing user data bits to be transmitted.
- (2) Filler blocks containing filler data bits provided by the GCF when the user data rate is insufficient to maintain contiguous blocks on line required for continuous line monitoring and error control.

Current capabilities for the GCF Mark III period provide the functional capabilities illustrated in Fig. 2. The GCF High-Speed Data Subsystem is standardized on a 1200-bit block size (message segment) and a line bit rate of 7200 b/s. The subsystem capabilities include a 22-bit error detection encoding/decoding polynomial code, two error status bits, and error control using two eight-bit fields. The error control field facilitates numerical serialization and acknowledgement numbers for error correction by retransmission.

The error correction capability has significantly reduced the post-pass time required for non-real-time replay of blocks received in error.

Figure 3 illustrates the High-Speed Data Subsystem and the GCF Subsystems located at the Central Communications Terminal.

B. Wideband Data Subsystem

The Wideband Data Subsystem consists of assemblies that switch, transmit, receive, process, distribute, test and monitor data requiring the use of bandwidths greater than those provided by standard high-speed data channels. The GCF Wideband Data Subsystem functionally illustrated in Fig. 4, together

with a listing of functional capabilities provided, includes standard wideband circuits as well as all intersite microwave (area microwave) capabilities. The Wideband Data Subsystem is used for the transmission of:

- (1) All DSN Telemetry System high-rate data that exceed High-Speed Data Subsystem capabilities.
- (2) Data interchange between the NOCC and GCF Communications Terminal at JPL.
- (3) Data interchange between DSSs within a complex via intersite microwave, including critical timing signals and receiver baseband signals for antenna arraying and signal combining systems support.
- (4) Simulation System Data from the Mission Control and Computing Center/Mission Operations Center to the DSSs.
- (5) DSN Test Support System data from the Network Operations Control Center to the DSSs.

The wideband data circuits for interchange of data between the DSSs and JPL are impressed with serial bit streams at a continuous line rate, typically 56 or 230.4 kb/s, divided into 4800-bit message segments (data blocks). Similar to the High-Speed Data Subsystem, the blocks are either data blocks or filler blocks inserted when the user data load is insufficient to maintain contiguous data blocks.

C. Voice Subsystem

The Voice Subsystem consists of GCF assemblies that switch, transmit, receive, distribute, test, and monitor transmissions originally generated in vocal form, and includes internal voice communications within the Deep Space Station Communications Complexes, DSSs, and the NOCC. The subsystem service provides capabilities between those areas and to non-DSN area interfaces as follows:

- (1) NOCC and DSS.
- (2) NOCC and MCCC/MOC (or remote MOC).
- (3) MOC and DSS for Command System backup.

The Voice Subsystem functional capabilities and key characteristics include:

- (1) Standard voice-data grade circuits for all traffic.
- (2) Conferencing capability on one intercontinental circuit during noncritical periods for all Deep Space Stations supporting a single project (individual circuits for each DSS during critical periods, resources permitting).
- (3) User-controlled intercomm switching.

- (4) Circuits used for high-speed data transmission (backup) if required.
- (5) Voice traffic recording in the central communications terminal upon request.

D. Teletype Subsystem

The teletype (TTY) subsystem uses an eight-level ASCII (American Standard Code for Information Interchange) national standard.

The subsystem consists of assemblies that switch, transmit, receive, distribute, test and monitor digital signals at a TTY line rate of 100 words per minute. The operational use of teletype continues to be deemphasized and is used primarily for emergency backup operational transmissions and administrative communications. Service functions and key characteristics include:

- (1) Handling Air Force Eastern Test Range (AFETR) generated predicts for DSN initial acquisition.
- (2) Transmitting nonoperational messages between the JPL Message Center and other locations.
- (3) Use of standard NASCOM format and the NASCOM communications processor for message switching.
- (4) Employment of time division multiplexing techniques to reduce trunk circuit costs.

E. GCF Monitor and Control Subsystem

The GCF Monitor and Control Subsystem consists of assemblies that collect, process, and display the status and performance of the GCF Subsystems in real-time. The GCF Monitor and Control Subsystem functional capabilities are illustrated in Fig. 5. Functions are implemented in minor subassemblies located at each DSS to interface station GCF status and performance indicators to the CMF for monitor block formatting and transfer to the Central Communications Monitor (CCM) Processor at JPL. The CCM also receives real-time status and performance information from local GCF subsystems. All real-time status and performance information received by the CCM is processed and displayed relative to preset standards and limits to facilitate operations monitoring and technical control. Information and alarms are displayed on continuous line performance and data flow throughput including error control.

F. Data Records Subsystem

The DSN requirements for the data record processing and production functions are implemented in the GCF Data Records Subsystem. The Data Records Subsystem consists of assemblies in the CCT that log in real-time, monitor, iden-

tify gaps, provide for processing and editing of data gap lists, control data gap recalls from the DSSs and the generation and accounting for Intermediate Data Records (IDRs) and fill-data records selected from records of the GCF real-time log.

The Data Records Subsystem maintains accountability of high-speed and wideband data, performs automatic recall (under operator control) of missing data, and generates near-real-time intermediate data records for delivery to the Mission Control and Computing Center.

G. Network Communications Equipment Subsystem

The Network Communications Equipment (NCE) Subsystem consists of GCF minicomputers and peripheral I/O assemblies that switch, transmit and receive data. The NCE Subsystem assemblies are located in the Network Data Processing Area (NDPA). The NCE assemblies comprise a GCF Area Communications Terminal located adjacent to the NDPA.

The NCE interchanges multiplexed block formatted data with the ECS assembly located in the CCT over three full-duplex 230-kb/s wideband data channels (see Fig. 6). This GCF-NDPA interface function provides for:

- (1) Processing data for transmission to and accepting data from the GCF CCT.
- (2) Multiplexing/demultiplexing and buffering data for all NDPA processors.
- (3) Routing data to and from NDPA processors.

V. Typical Configuration

The DSN GCF is designed for multiple mission support. Improvements and additions are integrated to meet new era and project requirements (Voyager and Pioneer-Venus requirements were completed in CY 1978) while continuing to support the Viking, Helios, and Pioneer 6 through 11 Projects. Plans for west coast switching center support of the IRAS Project are completed. Requirements for the ISPM and Galileo projects are being defined and included in ongoing plans. Figure 7 illustrates, in general, the GCF configuration for support of these projects. Additionally, remote information centers and other non-DSN NASCOM-serviced installations on the west coast are serviced through the NASCOM West Coast Switching Center, an integral part of the GCF 20/Central Communications Terminal at JPL.

VI. Implementation Activities

A. GCF-NOCC Reconfiguration

The task to reconfigure the CCT was begun with requirements specifications established in March 1979 and a responsive design review in October 1979. The reconfigured CCT was completed in the second quarter of 1981. The reconfigured CCT has:

- (1) Reduced the number of computers in use.
- (2) Provided a more timely IDR production capability.
- (3) Reduced the complexity of the man-machine interface.
- (4) Reduced manpower required at the CCT.
- (5) Released the wideband data subsystem coded multiplexer/demultiplexers for reinstallation at the 34-meter DSSs.
- (6) Increased the capacity to handle simultaneous wideband data lines at the CCT.
- (7) Provided a central console at the CCT for control and monitoring of all GCF subsystems.

B. Mark IVA GCF

Implementation planning and design to meet the requirements of the DSN's Mark-IV Long Range Plans was begun in late 1979. The priority design and implementation effort will be to consolidate the data communications interfaces to a single communications processor interface at each of the three Deep Space Communications Complexes (DSCC). This single interface processor will accommodate the DSN's Networks Consolidation Program plans for a single signal processing center located at each DSCC. Other less significant GCF changes and additions required within the DSCCs along with changes at the CCT are included in this effort, which is to be completed in 1985. With the consolidation of the networks, the GCF will see a significant increase in data communications requirements as both deep space and high elliptical near-earth orbiting spacecraft are tracked, and acquired data will pass through the single communications processor at the DSCC. Modifications will be made in the CCT to accommodate the new DSCC interfaces and the new type of remote operations control centers.

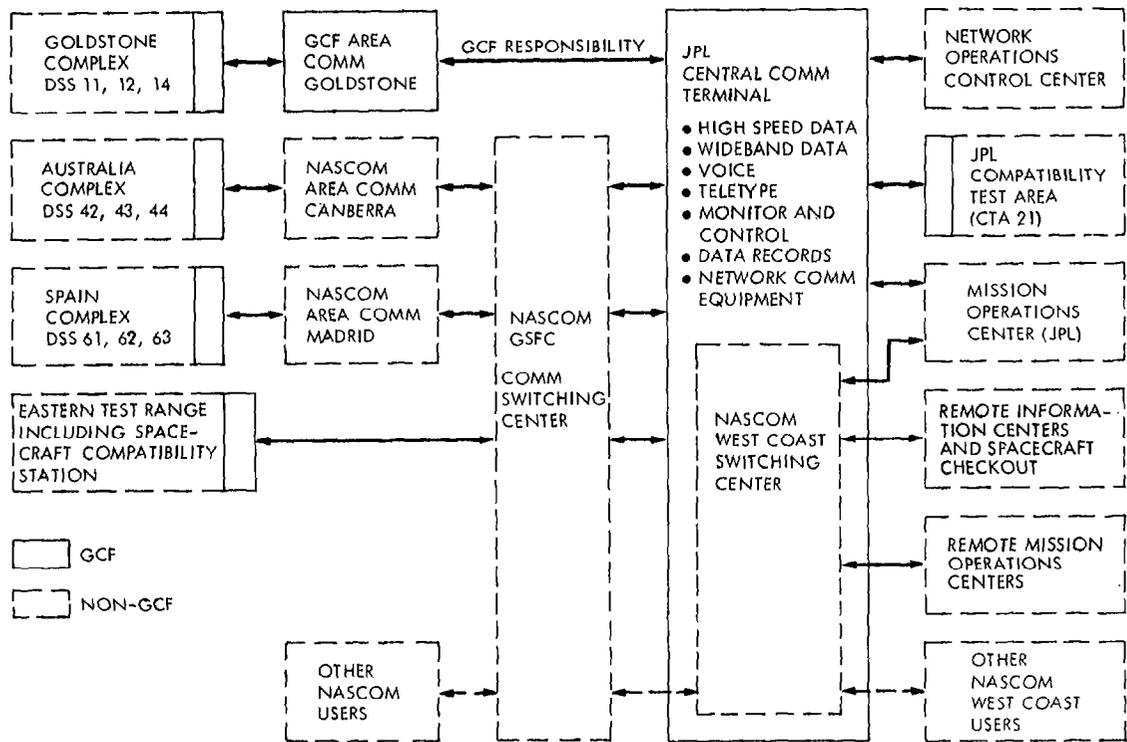


Fig. 1. GCF configuration

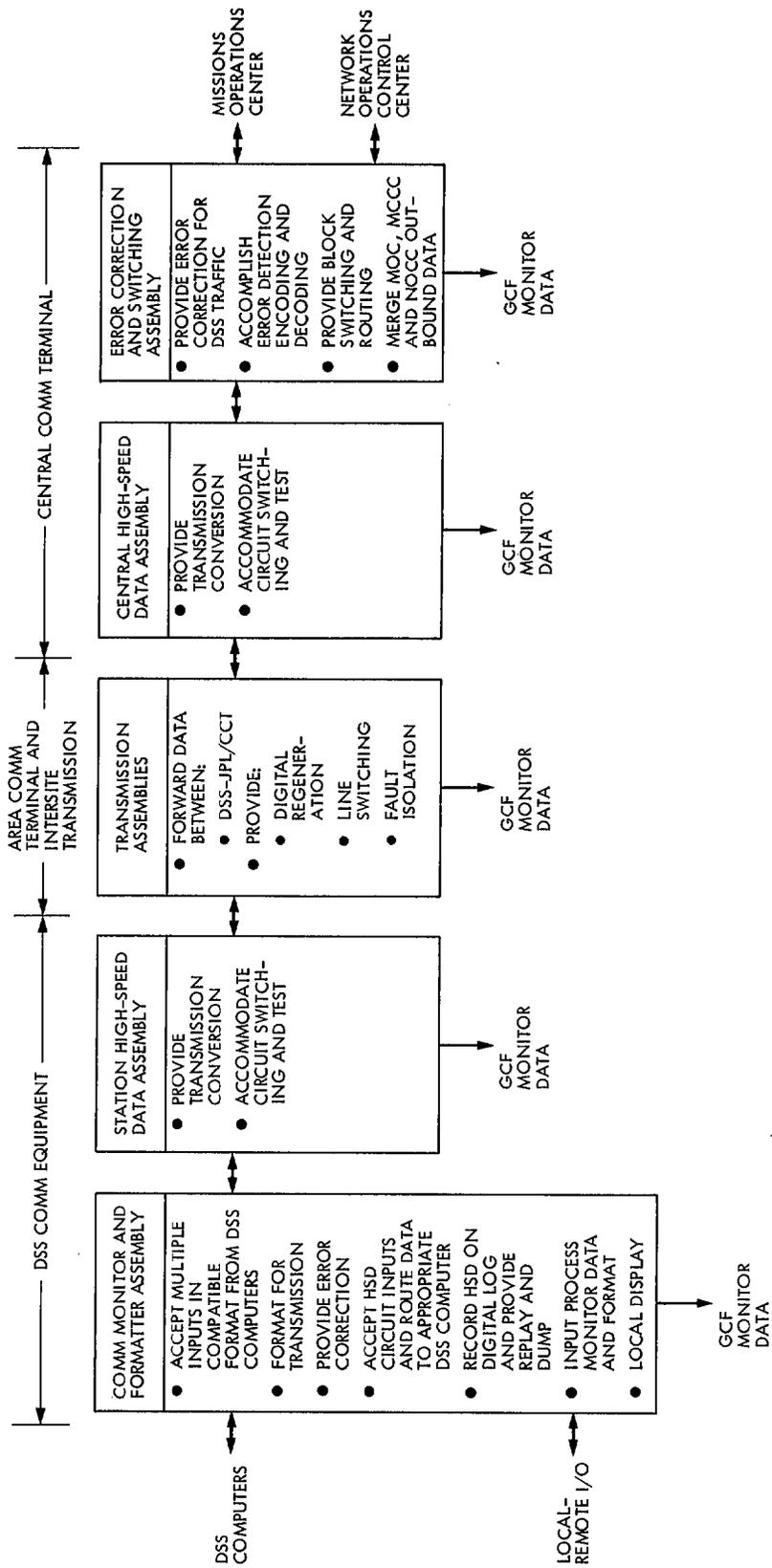


Fig. 2. GCF High-Speed Data Subsystem functional capabilities

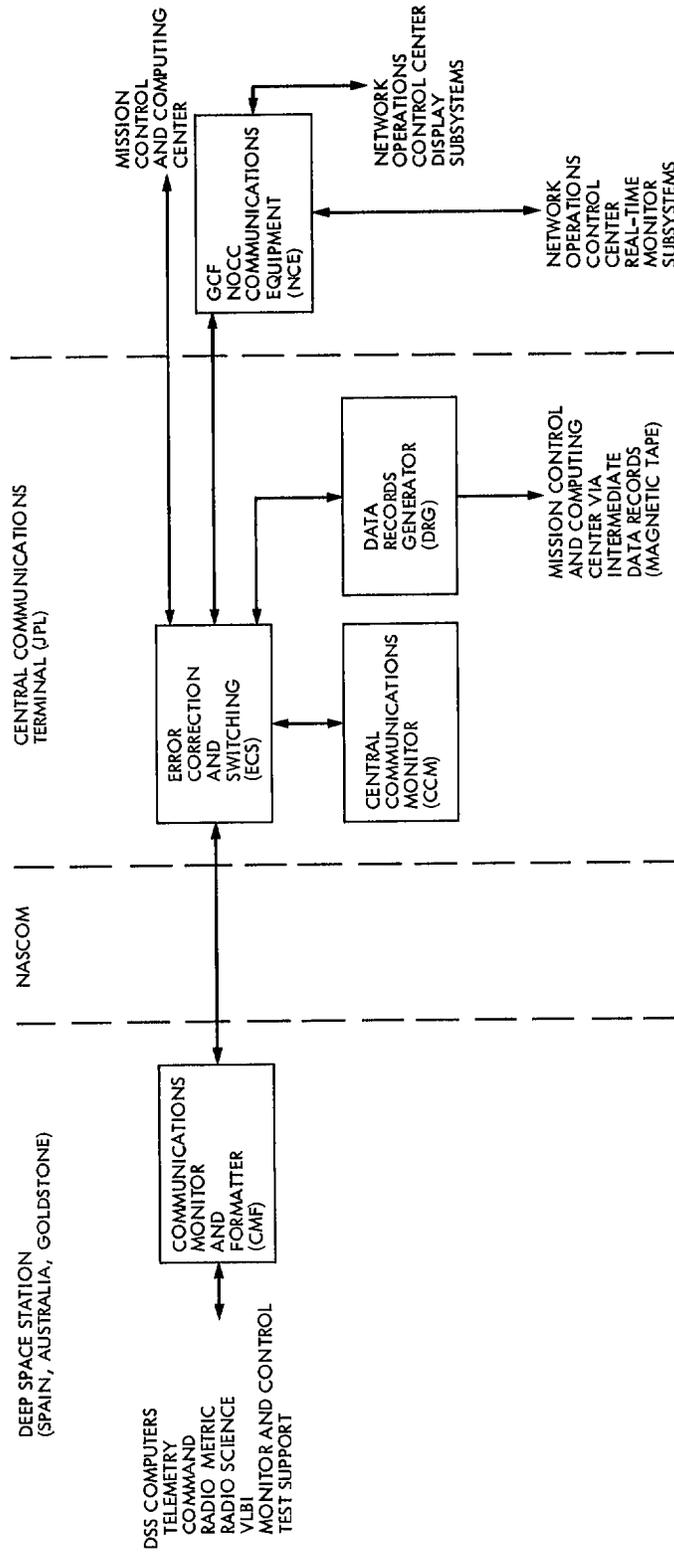


Fig. 3. GCF High-Speed Data Subsystem and Central Communications Terminal Subsystems and interfaces

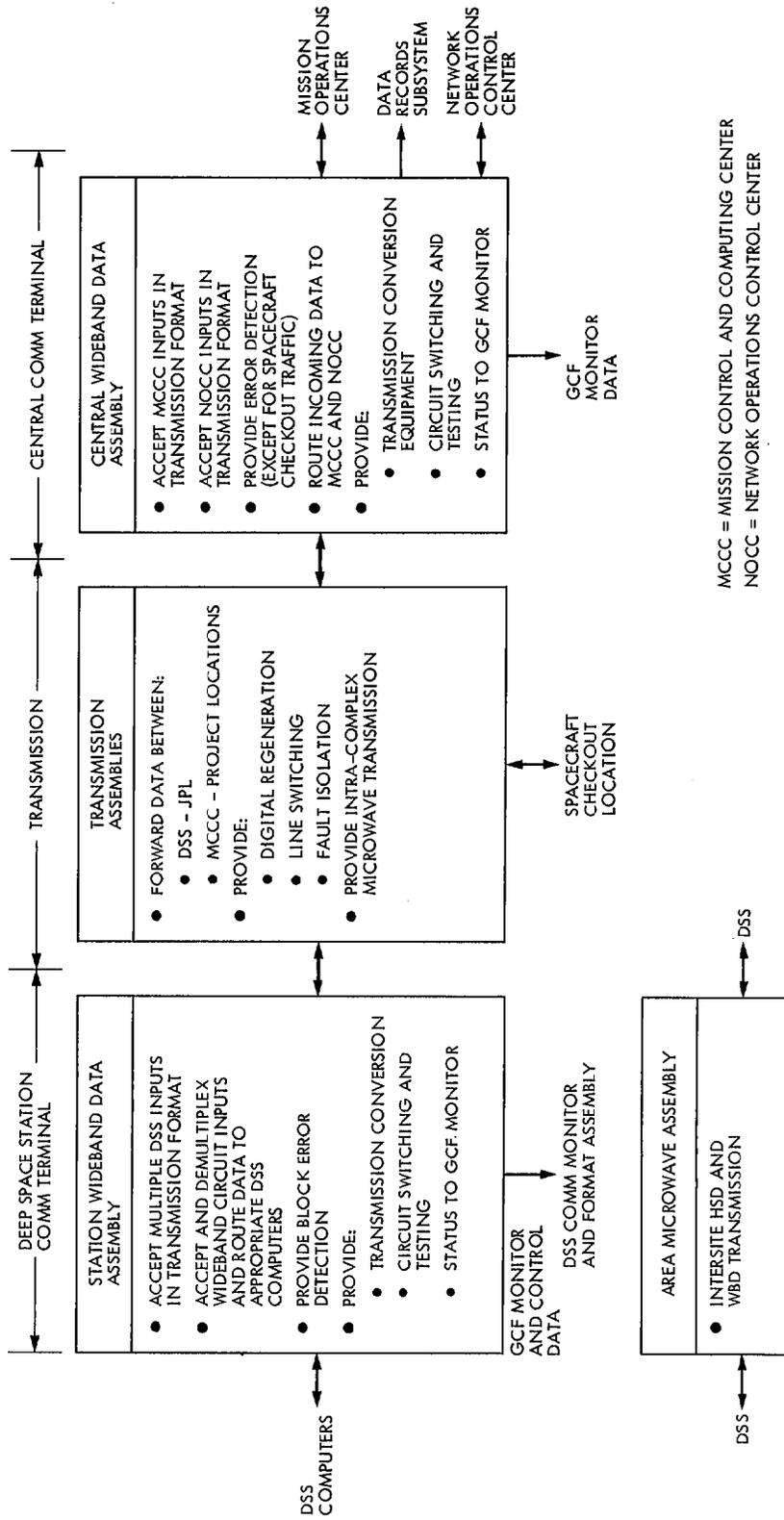


Fig. 4. GCF wideband subsystem

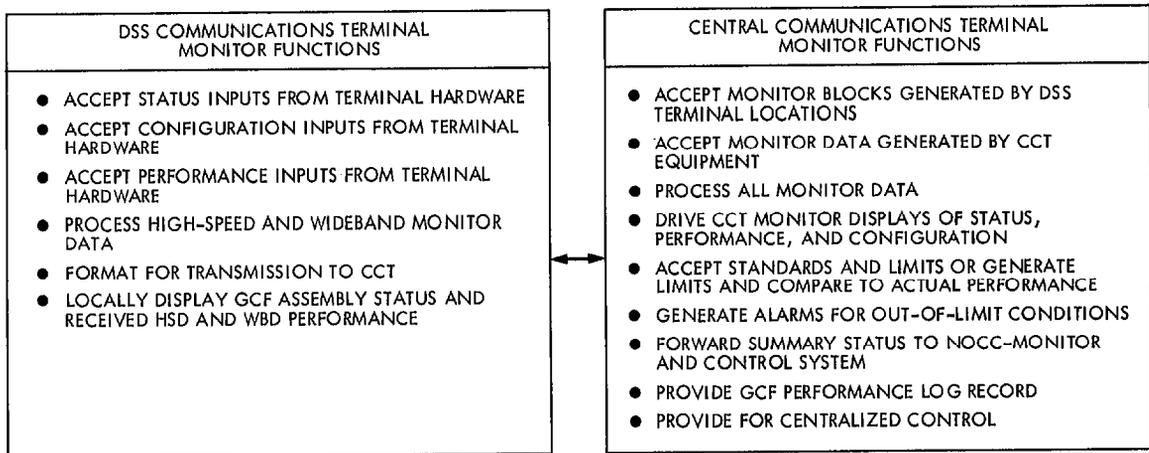


Fig. 5. GCF Monitor and Control Subsystem functional requirements

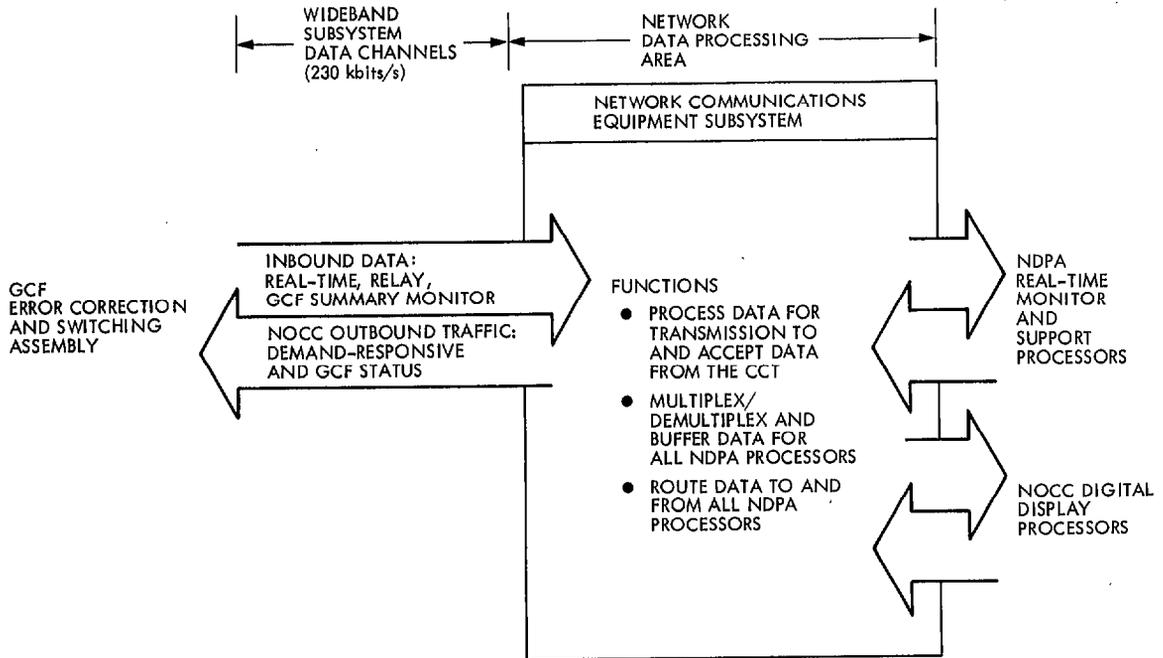


Fig. 6. GCF Network Operation and Control Communications Equipment Subsystems

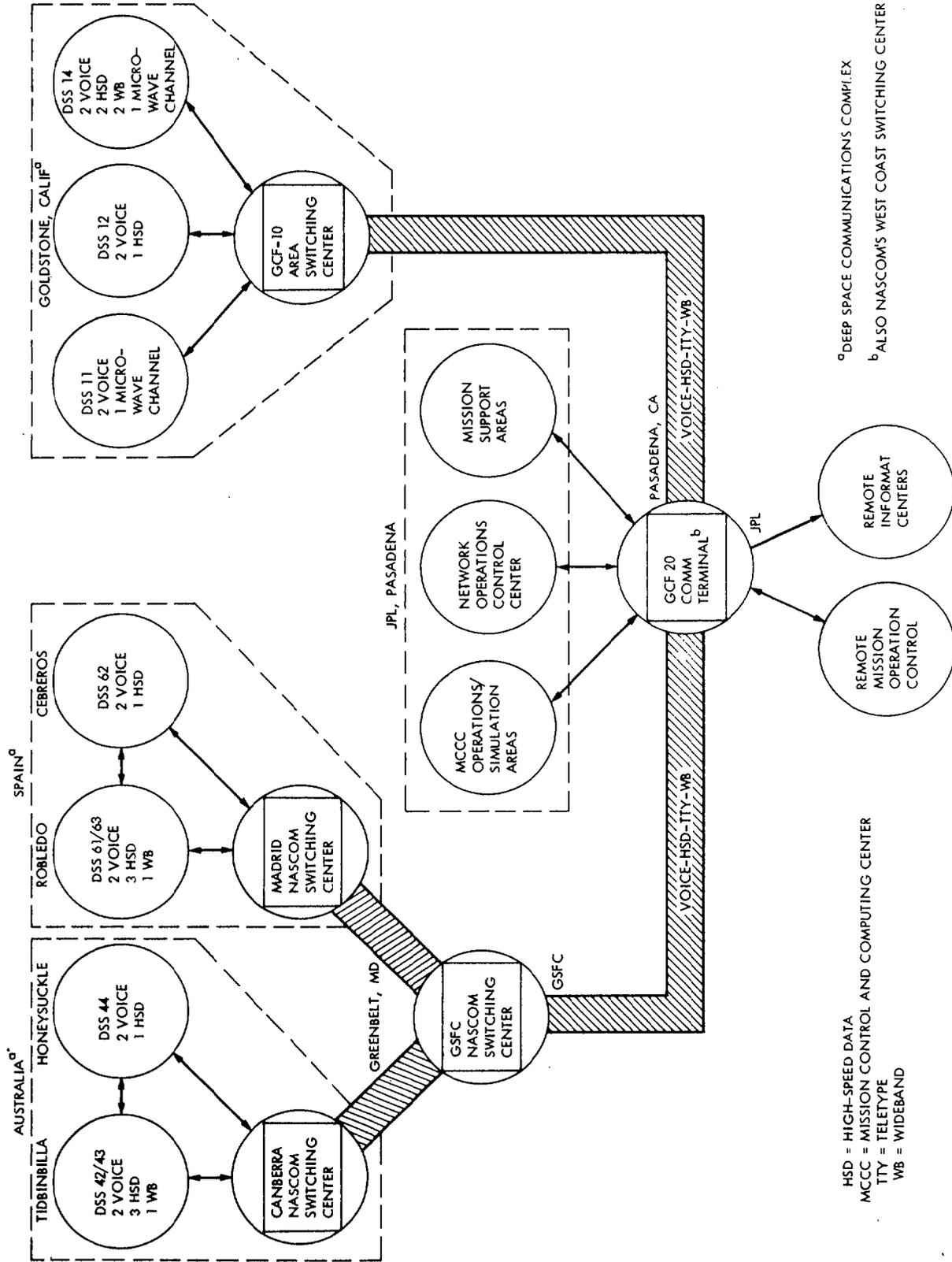


Fig. 7. DSN support locations and GCF-NASCOM circuit requirements