Mark III-77 DSN Command System

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A description of the Mark III-77 DSN Command System configuration is discussed. A comparison is made with the Mark III-75 System Configuration to explain the implementation required to establish the Mark III-77 System Configuration.

I. Introduction

The DSN Command System, one of the six Network systems, will be undergoing implementation during the next 15 months that will lead to the Mark III-77 configuration. Of significance is the implementation that will occur at the Deep Space Stations (DSS) and in the Ground Communications Facility (GCF). On December 16, 1976, installation of the Mark III-77 configuration was completed on the first[1] DSS (DSS 12 at Goldstone). The station was brought back on line at that time for flight support. The first two months of operational use is planned for mission demonstration passes and station personnel training. (At the time of submittal of this article, the second station (DSS 62 in Spain) is off line and installation of the Mark III-77 configuration is in process.) Stations will be taken off line (nonoperational), implemented per the Mark III-77 configuration, and returned to flight support status. The last station to be implemented will be DSS 11 at Goldstone in March 1978. Implementation in the GCF is occurring at two locations. At the stations the implementation is consistent with the station-by-station reconfiguration schedule. At JPL, implementation is planned for October 1977.

Figure 1 provides a block diagram of the Mark III-75 DSN Command System. Figure 2 provides a block diagram of the Mark III-77 DSN Command System. Comparison of the two figures shows that major configuration changes will occur in two subsystems of the DSN Command System: the DSS Command Subsystem and the GCF High-Speed Data Subsystem.

The Mark III-77 DSN Command System will support the ongoing Pioneers 6 through 11, Helios 1 and 2, and the Viking missions. The configuration will also support the yet to be launched Mariner-Jupiter-Saturn 1977 and Pioneer Venus 1978 missions. The configuration is multimission and will consist of no mission dependent hardware or software elements.

[1]CTA 21 (Compatibility Test Area) at JPL and STDN (MIL 71) at Cape Canaveral were implemented prior to DSS 12.

II. Deep Space Station Implementation

Figure 3 contains a block diagram of the Mark III-77 Deep Space Station configuration and denotes items requiring implementation or modification from the Mark III-75 configuration. The major modifications are shown in the exploded view. Implementation plans include the following:

(1) Replacement of the existing Telemetry and Command Processors (TCPs) with dedicated Command Processor Assemblies (CPAs) at all stations.

(2) A change in interface between the DSS Command Subsystem and the GCF High-Speed Data Subsystem (i.e., the Star Switch Controller).

(3) Implementation of a computer at the terminal end of the GCF High-Speed Data Subsystem (i.e., the Communications Monitor and Formatter Assembly (CMF)).

(4) A change in interface between the DSS Command Subsystem and the DSS Monitor & Control Subsystem. This includes an interface via the Star Switch Controller between the CPA and the Monitor and Control Computer (the Digital Instrumentation Subsystem (DIS)). This interface change also includes implementation of a Data System Terminal (DST) that places the DSS Command Subsystem under the DSS centralized operations concept.

(5) A change in interface between the Frequency & Timing Subsystem (FTS) and DSS Command Subsystem. Includes the implementation of a Time Format Assembly (TFA).

(6) Minor modifications to the Command Modulator Assembly (CMA).

(7) An upgrade of the DSS Transmitter Subsystem at DSS 12 and 62; upgrade from 10 kW to 20 kW.

The CPA is a Modcomp Computer, Model II-25. Its implementation is part of the DSN plans to replace the existing XDS-920 computers in the Network. The first phase of this replacement is being carried out via the DSN Mark III Data Subsystem (MDS) Implementation Project. (Telemetry Processor Assemblies (TPAs), Metric Data Assemblies (MDAs), and Communication Monitor and Formatter Assemblies are being implemented by this project simultaneously with the CPAs.) In the Mark III-75 configuration, the DSS command processing function shared the same computer with telemetry. In the Mark III-77 configuration, the command function resides in a dedicated command computer. (Note backup available at each DSS.) This newer dedicated computer will provide higher reliability, greater processing speed, and more core available for the command function. The higher reliability will derive from isolation from the telemetry function. The increased processing speed will allow the DSN to support higher spacecraft command bit rates. In the Mark III-75 configuration, where the command and telemetry functions were shared in the XDS-920 TCP, the DSN had reached the limit of command bit rate support. The 8 b/s used to support the Helios mission very nearly matched the limit of the DSN capability. The 16-b/s command rate required by the Mariner-Jupiter-Saturn 1977 mission required the DSN to replace the TCP. The CPA processing speed will allow the DSN to support expected major increases in command bit rates for future missions.

As part of the implementation at the DSS, Star Switch Controllers (SSC) are to serve as the intercomputer communications hardware devices. Connected to the SSCs will be two CPAs, two TPAs, one MDA, one DIS, and two CMFs. All communication between the computers is via the SSCs.

The Mark III-77 configuration includes the implementation of two Modcomp II-25 computers (CMFs, prime and backup) at each DSS for the terminal end of the GCF. The prime functions of the CMF include interfacing with the communication equipment at the DSS to receive/transmit high-speed data blocks from/to JPL, to communicate with the station computers (CPAs, TPAs, MDA, and DIS) via the Star Switch Controllers, and to provide a centralized station digital original data record (ODR). It should be noted that the centralized ODR concept is different from what exists in the Mark III-75 configuration. In the Mark III-75 configuration the TCP and DIS provided digital tape recordings (ODRs) of all inbound and outbound high-speed data blocks. In the Mark III-77 configuration, this function has been centralized where the CMF logs all station inbound and outbound data.

As in the Mark III-75 configuration, DSS Command Subsystem status data is provided to the DSS Monitor and Control Subsystem in the Mark III-77 configuration. However, in the Mark III-77 configuration, the data are communicated via the Star Switch Controller. The major change that is occurring in the interface between these two subsystems is due to the implementation of the DSS centralized input/output device (the DST). The Data System Terminal Assembly (DST) consists of two cathode ray tubes (CRTs) and a prime and backup keyboard. After each computer has been loaded, all operator input/output functions can be accomplished from the DST. This will permit a more rapid operator response for controlling and monitoring the station computer-based subsystems.

With the implementation of the Modcomp Computers, a new interface with the Frequency & Timing Subsystem is required. The Time Format Assembly (TFA) provides the required interface. The TFA furnishes GMT and timing pulses of 1, 10, 100, and 1000 pulses per second to the CPA.

Minor modifications are to be accomplished in the Command Modulator Assembly (CMA) during the Mark III-77 upgrade. Due to implementation of CPA (CPA does not have an analog to digital converter whereas the TCP does), the method of checking the voltage output level of the CMA to the exciter will be changed. A voltage comparator will be installed in the CMA and a good or bad signal will be provided to the CPA software. In the Mark III-75 configuration, the TCP software does the comparison to nominal limits. Changes will also be made that will invert bit sync of Manchester encoded coherent phase-shift keying (PSK) data to make it compatible with the MJS 77 spacecraft (inverted from Viking). Additionally, an improvement will be made where symbol-by-symbol checking of Manchester encoded data will be accomplished. (In the Mark III-75 configuration, checking is done on a bit-by-bit level.)

As indicated in Fig. 3, implementation is required in the DSS Transmitter Subsystem. DSS 12 and 62 transmitters are to be upgraded from 10 kW to 20 kW. This will provide 20-kW transmitter capabilities at all DSN stations.

III. Ground Communications Facility Implementation

Due to the nature of support provided by the Ground Communications Facility (GCF) High-Speed Data Subsystem, the implementation of the Mark III-77 configuration will coexist with the Mark III-75 configuration for a significant period of time. Figure 4 provides a block diagram of the dual configurations that will exist from late CY 1976 through late CY 1978. The reasons that the dual configurations have to remain in existence for two years are:

(1) Both Mark III-75 configured stations and Mark III-77 configured stations will exist through March 1978.

(2) The committed interface to the Viking and Helios missions will be maintained through end of missions.

The implementation of the Mark III-77 GCF High-Speed Data Subsystem will occur at the Deep Space Stations and at the Jet Propulsion Laboratory. At the DSS, the CMF computers are being implemented on a schedule consistent with the station-by-station upgrade to the Mark III-77 configuration. In the Central Communications Terminal (CCT) at JPL, three types of functional computer assemblies are planned to be implemented for the Mark III-77 configuration. The three types of assemblies are: (1) Error Detection Correction (EDC), (2) High-Speed Switch (HSW), and (3) Central Communications Monitor (CCM). All computers will be Modcomp. Implementation in the CCT is planned to be completed in October 1977 for initial Pioneer Venus 1978 testing.

The EDC assembly, as previously stated, will be physically installed and in line with data flow in late 1977. The functions of this assembly will be to establish a protocol with the GCF computer (CMF) at a Deep Space Station such that short line outages and block errors are corrected by retransmission. With this correction scheme, the DSN should approach 100 percent in the delivery of real-time data. The primary driver for this implementation is to cut down on the station time and personnel effort for posttrack replay of missed telemetry data. The DSN can then more easily meet the completeness criteria for project data records with this real-time correction by retransmission scheme.

The HSW provides the data block routing function for the GCF High-Speed Data Subsystem at JPL. Data are received from a DSS and routed to the appropriate destination – Ames Research Center, Network Operations Control Center (NOCC), and/or Mission Control and Computing Center (MCCC). Likewise, data destined for a DSS are received from Ames, NOCC, or MCCC, and routed to the appropriate DSS.

Included in the Mark III-77 configuration is the Central Communications Monitor Assembly (CCM). This assembly will receive status data from GCF equipment at a DSS (the CMF) and at the CCT. These data will be processed and displayed for all data streams such that the GCF status can be monitored from one central location.

IV. Network Operations Control Center Implementation

As can be seen from Fig. 1 and Fig. 2, there are no changes from the Mark III-75 to Mark III-77 configuration in the NOCC affecting the DSN Command System. The physical assemblies do not change. There are some changes in the nature of software sustaining effort – improvements in operator displays, inputs, etc.

V. Future Plans

This article primarily discusses the physical configuration of the Mark III-77 DSN Command System rather than the

functional capabilities. Due to the nature of the DSS implementation occurring over an extended period of time, in which a given project is supported by both Mark III-75 and Mark III-77 configured stations, the software functions performed by the CPA closely match those of a TCP (see Progress Report 42-29 for description). When all TCPs in the DSN have been replaced by CPAs, plans are to update the software. The prime change will be to greatly increase the command storage capability at a DSS such that outages upstream in the system have little, if any, affect on the function of commanding a spacecraft. The operation and capabilities resulting from that implementation will be discussed in a later article.

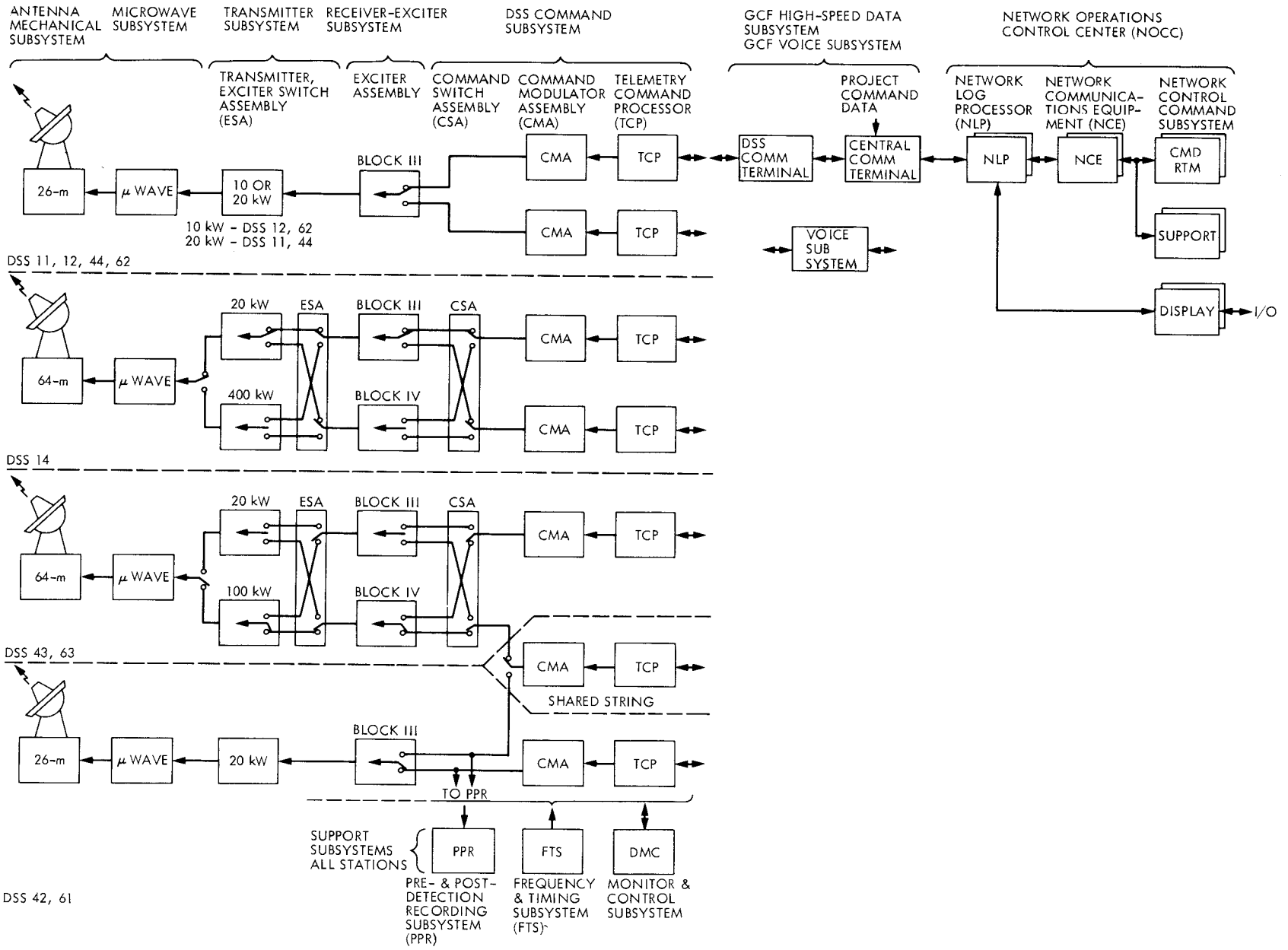

Fig. 1. DSN Mark III-75 Command System

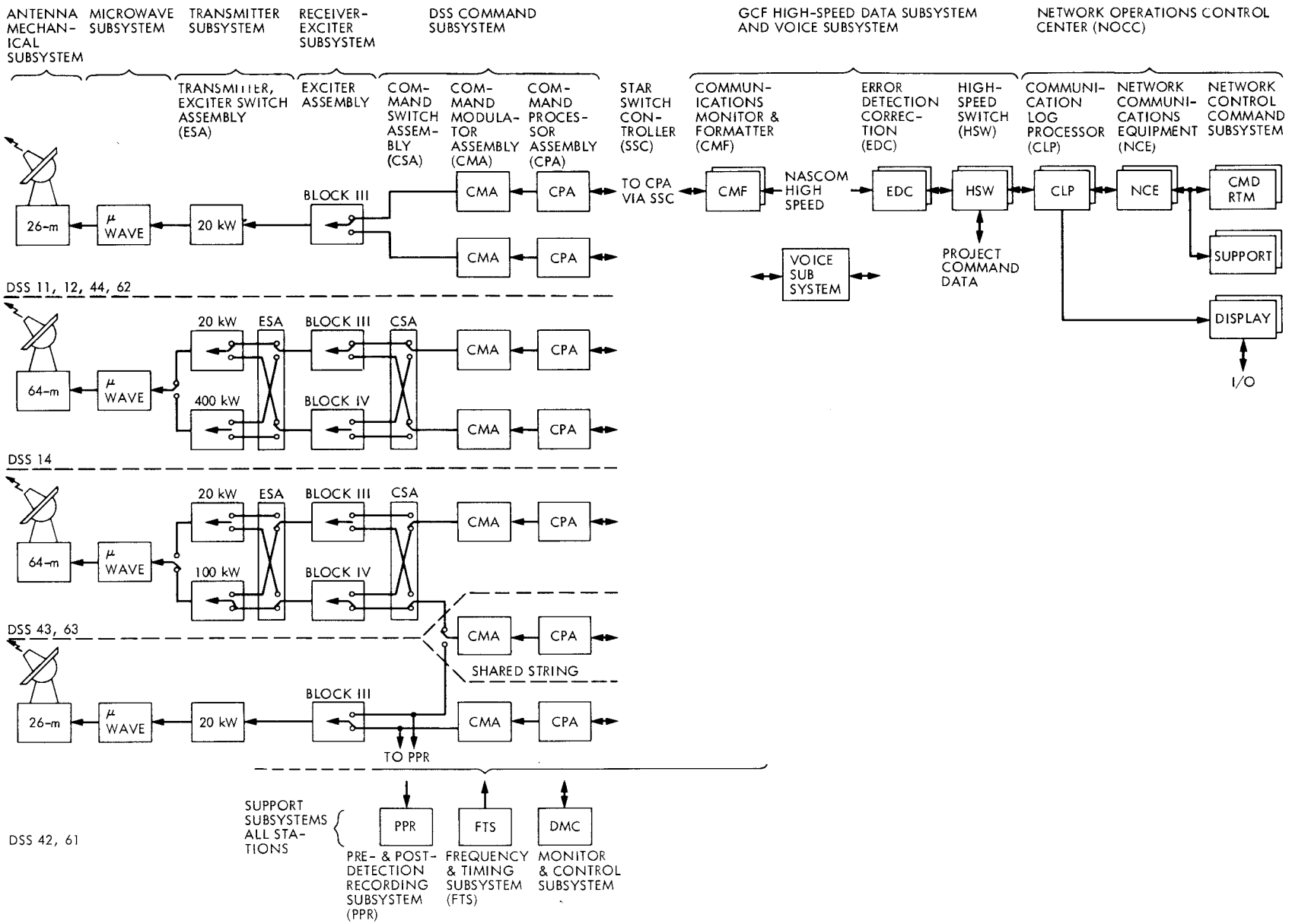

Fig. 2. DSN Mark III-77 Command System

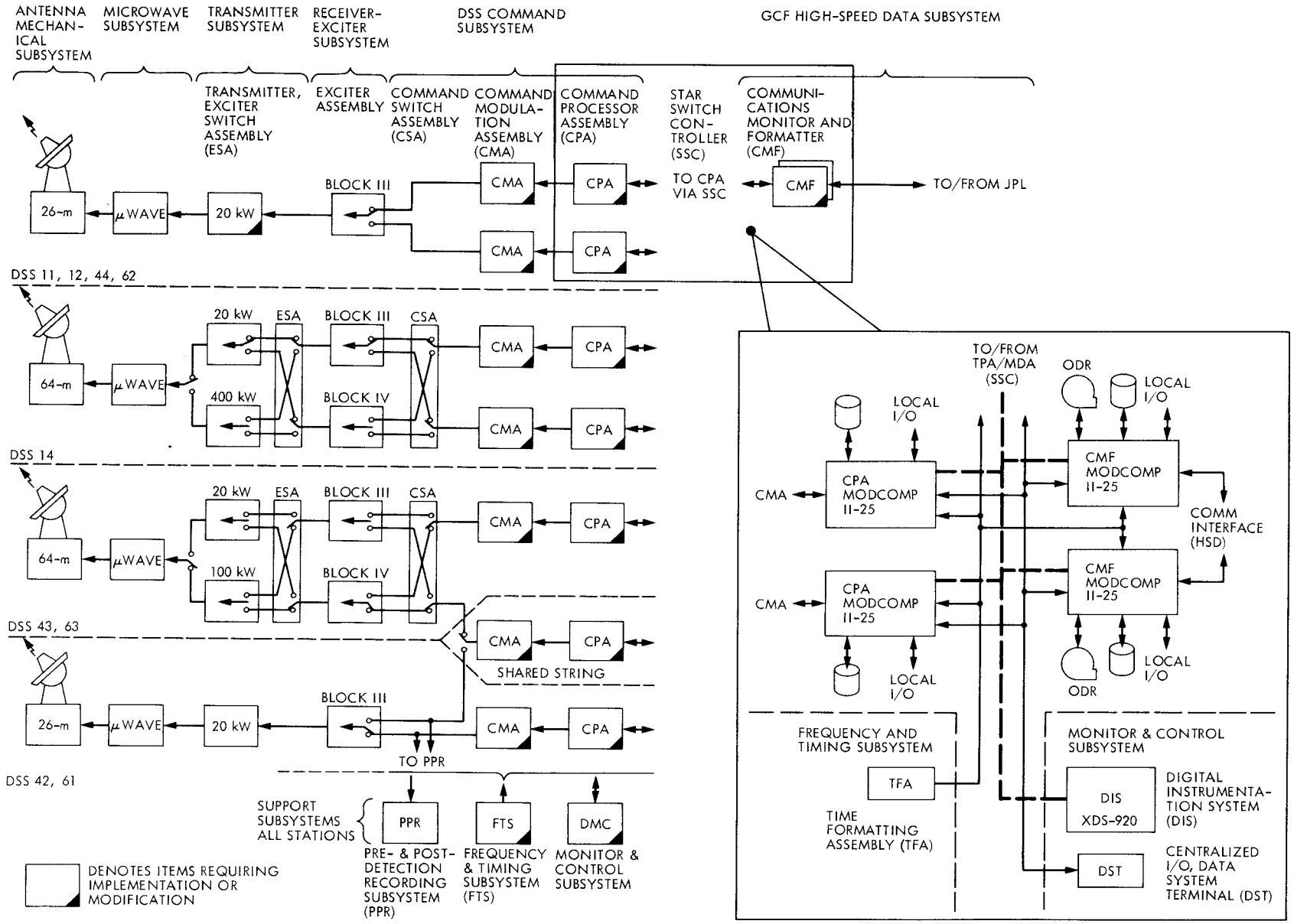

Fig. 3. Deep Space Station implementation of DSN Mark III-77 Command System

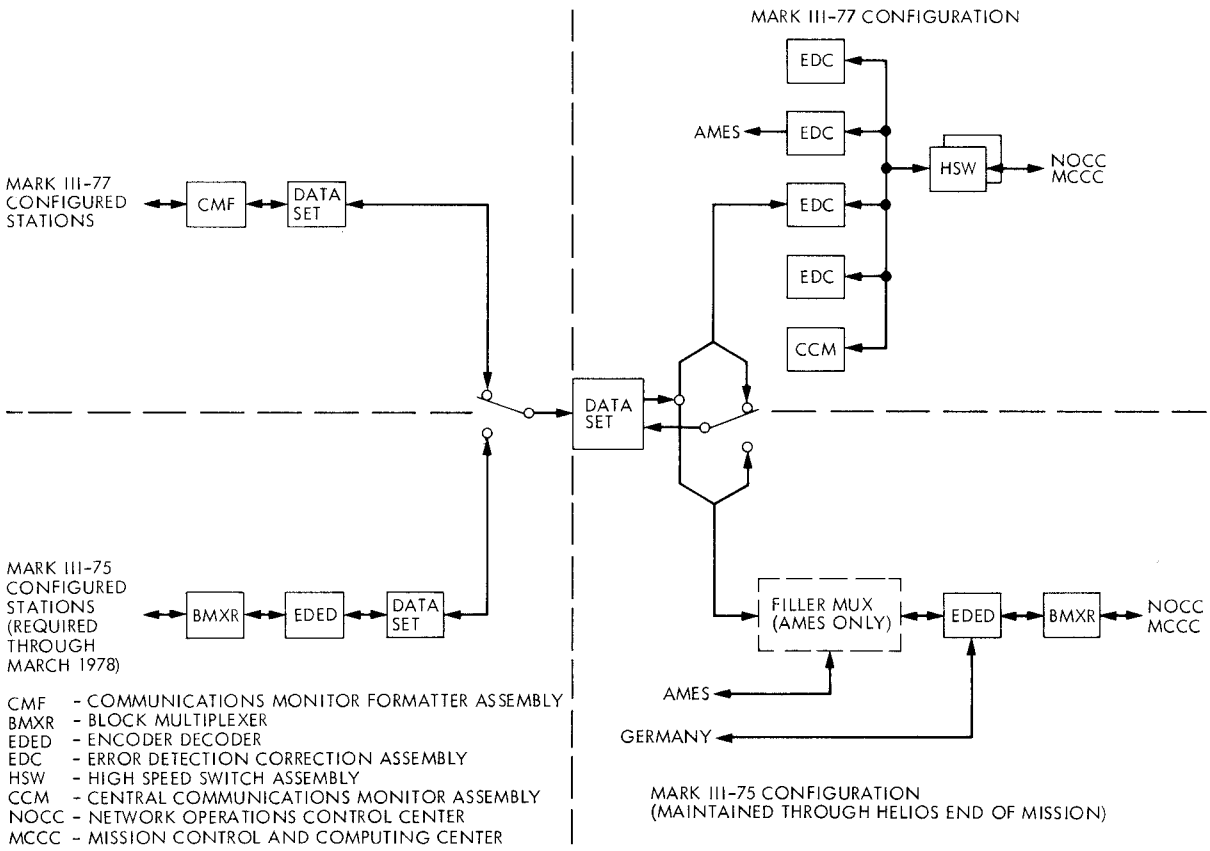

Fig. 4. GCF High-Speed Data Subsystem configuration (1976 through 1978)