DSN Monitor and Control System, Mark III-77

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A description of the DSN Monitor and Control System, Mark III-77 configuration is discussed. The implementation is noted that explains the evolution from the Mark III-75 to the Mark III-77 configuration.

I. Introduction

The DSN Monitor and Control System, one of the six DSN systems, is currently undergoing implementation that will lead to the Mark III-77 configuration. Implementation is occurring at the Deep Space Stations (DSS), in the Ground Communications Facility (GCF), and at the Network Operations Control Center (NOCC). Implementation is occurring over a 17-month interval at the Deep Space Stations. The first station, DSS-12, completed the Mark III-77 configuration in November 1976. (At the time of submittal of this article, DSS 14, DSS 44, and DSS 62 have completed reconfiguration, with DSS 42 and 43 in process.) The last station to be reconfigured will be DSS 11 in March 1978. Each station is nominally offline for two months for reconfiguration. This two month period is followed by two months (nominal) of test and training before being returned to full flight operations support status. The implementation of the Mark III-77 configuration in the GCF is occurring at two locations – the Deep Space Stations and at JPL. At the Deep Space Stations, the implementation is consistent with the station-by-station Mark III-77 reconfiguration schedule. At JPL, implementation of the Mark III-77 GCF configuration is scheduled for completion in November 1977. At the NOCC the implementation consisted of software modifications to simultaneously process data from the Mark III-77 reconfigured stations and the Mark III-75 configured station. The schedule for this implementation was consistent with the first station (DSS 12) coming on line in the Mark III-77 configuration.

Figure 1 provides a block diagram of the DSN Mark III-77 Monitor and Control System. Major implementation (from the Mark III-75 to Mark III-77 configuration) is noted on the block diagram. This configuration is to support the ongoing Pioneer 6-11, Helios 1 and 2, and Viking missions. Further, this configuration is to support the yet to be launched Voyager 77 and Pioneer Venus 78 missions. (The Voyager spacecraft will be launched by the time this article is published.)

II. Deep Space Station Implementation

Major implementation or modifications are occurring at the Deep Space Stations to develop the Mark III-77 configuration. The major implementation includes:

(1) The Star Switch Controllers (SSC) to serve as the intercomputer hardware communications device.

(2) The station centralized input/output device for the computer based subsystems.

(3) The software in the station monitor computer (XDS 920, Digital Instrumentation Subsystem).

(4) The Station Monitor and Control (SMC) console.

The Star Switch Controllers provide the heart of the data flow paths in the computer network at the stations. Modcomp

II-25 computers are being implemented, as part of the Mark III Data Subsystem upgrade, for the command, telemetry, tracking, and communication functions. These computers pass system data to JPL, input/output (I/O) data to the centralized I/O device, and subsystem to subsystem data, via the Star Switch Controllers. Figure 2 provides a block diagram of a typical station Star Switch Controller and computer configuration. The centralized I/O device consists of two (prime and backup) CRTs with keyboards and a character printer. This centralized I/O device provides the station with the capability for a single operator to control the command, telemetry, tracking, and communications computers. The CRTs have paging capability with the first page being for operator input and response display, as well as a single line status display for each of the computers being serviced by the centralized I/O device. Page two provides detailed status, upon operator request, for all the computer based subsystems. The character printer provides a centralized hardcopy log of operational alarms and events from the computers.

The software in the station monitor computer underwent major modifications to accommodate the Mark III-77 reconfiguration. Although the function remained similar, significant changes occurred in the software to accommodate data structure changes in the interfaces to the command, telemetry, tracking, and communication computers. Additionally, major changes occurred to accommodate the protocol and timing characteristics of the Star Switch Controllers.

The Station Monitor and Control (SMC) console provides a centralized station operator position for control and monitoring of the non-computer based subsystems. The purpose of implementing this assembly was to minimize station operations costs by minimizing the number of subsystems that required a local operator. The SMC console was installed at all stations during calendar year 1976 and early calendar year 1977.

III. Ground Communication Facility Implementation

The implementation of the Mark III-77 Ground Communication Facility (GCF) high speed data subsystem will be complete in November 1977. However, the nature of the GCF support is such that the Mark III-77 configuration will co-exist with the Mark III-75 configuration through late CY 1978. The existing Mark III-75 configuration at the Jet Propulsion Laboratory will be maintained through the Viking and Helios end of missions (late CY 78). Additionally, the Mark III-75 configuration at the Deep Space Stations will exist until the last station is reconfigured (March 1978, DSS 11). Figure 3

provides a block diagram of this dual Mark III-75 and Mark III-77 GCF configuration.

At the Deep Space Stations, the Communication Monitor and Formatter (CMF) computer is being implemented on a schedule consistent with the station-by-station Mark III-77 reconfiguration. The CMF interfaces with the station computers via the Star Switch Controllers to pass high speed data to and from the station.

At the Jet Propulsion Laboratory, in the GCF Central Communications Terminal (CCT), three types of functional computers are planned to be implemented for the Mark III-77 configuration. An Error Detection Correction (EDC) assembly, a High Speed Switch (HSW) assembly, and a Central Communication Monitor (CCM) assembly are planned for implementation.

The function of the EDC assembly is to establish a protocol with the CMF computer at a Deep Space Station and perform error detection and correction by retransmission for block errors and short line outages. The purpose of this implementation is to provide a more reliable real time data delivery service to the flight projects, as well as cut down on the non-real time playback of data after a spacecraft track. With this error correction by retransmission, it is expected that 100% real time HSD delivery to flight projects will be approached.

The HSW assembly provides for automatic routing of high speed data blocks between the appropriate Deep Space Station, the Mission Control and Computing Center (MCCC), the Network Operations Control Center (NOCC), and Ames Research Center (ARC). The automatic routing function will be accomplished by software by use of destination codes contained within the high speed data messages.

The CCM provides the GCF and Network operations personnel with information regarding the GCF status. Status data is received from the CMF at the Deep Space Stations, and from the equipment in the Central Communication Terminal, and displayed to operations personnel.

IV. Network Operations Control Center Implementation

Major changes to the Network Operations Control Center (NOCC) monitor software occurred for the Mark III-77 reconfiguration. Although similar in function, the high speed data received and processed from the Mark III-77 reconfigured stations changed significantly in structure. Additionally, simultaneous processing of Mark III-75 and Mark III-77 station data was required. Both these items caused significant data processing and software timing changes in the NOCC monitor software.
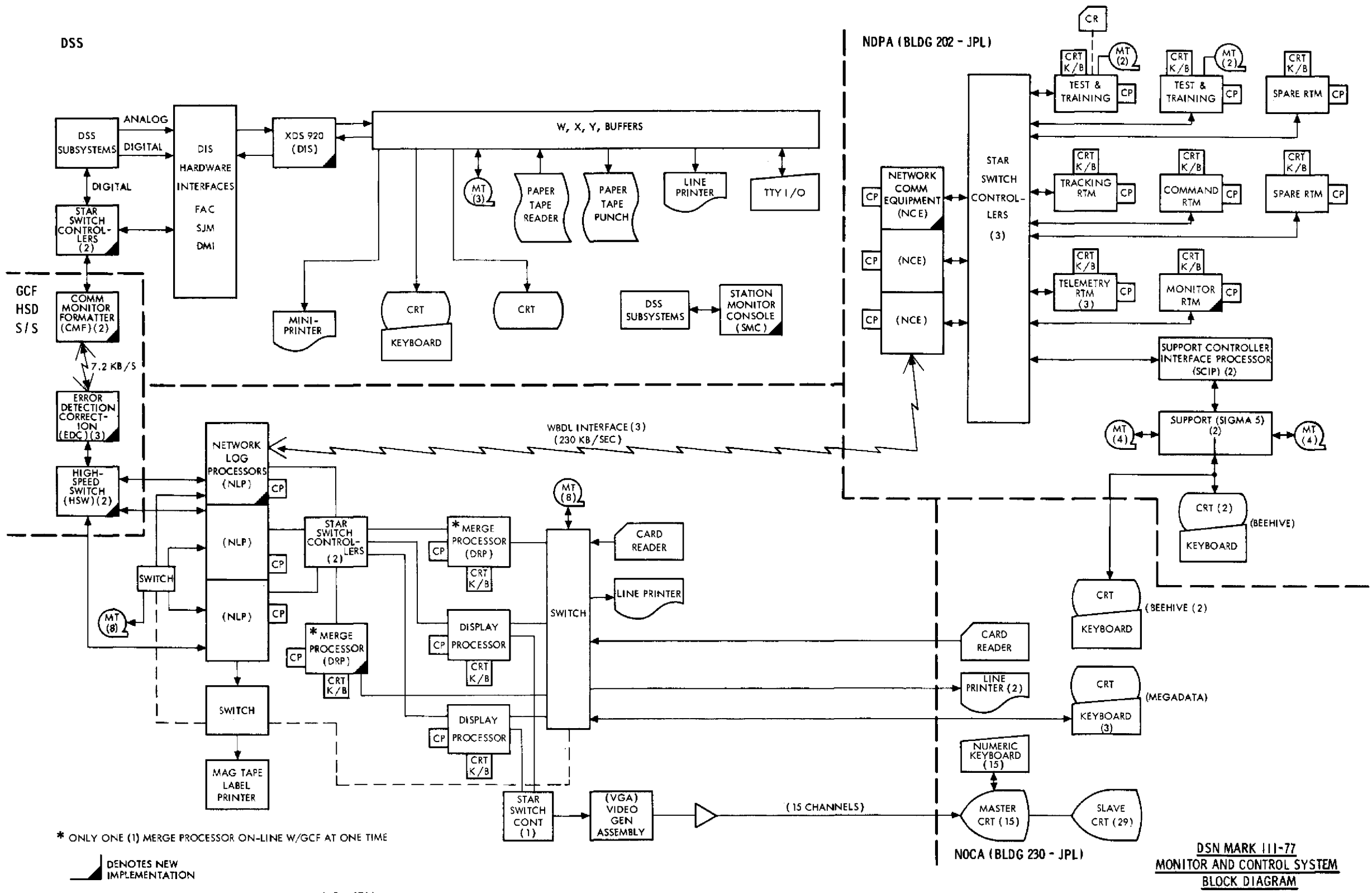
Fig. 1. DSN Mark III-77 Monitor and Control System block diagram
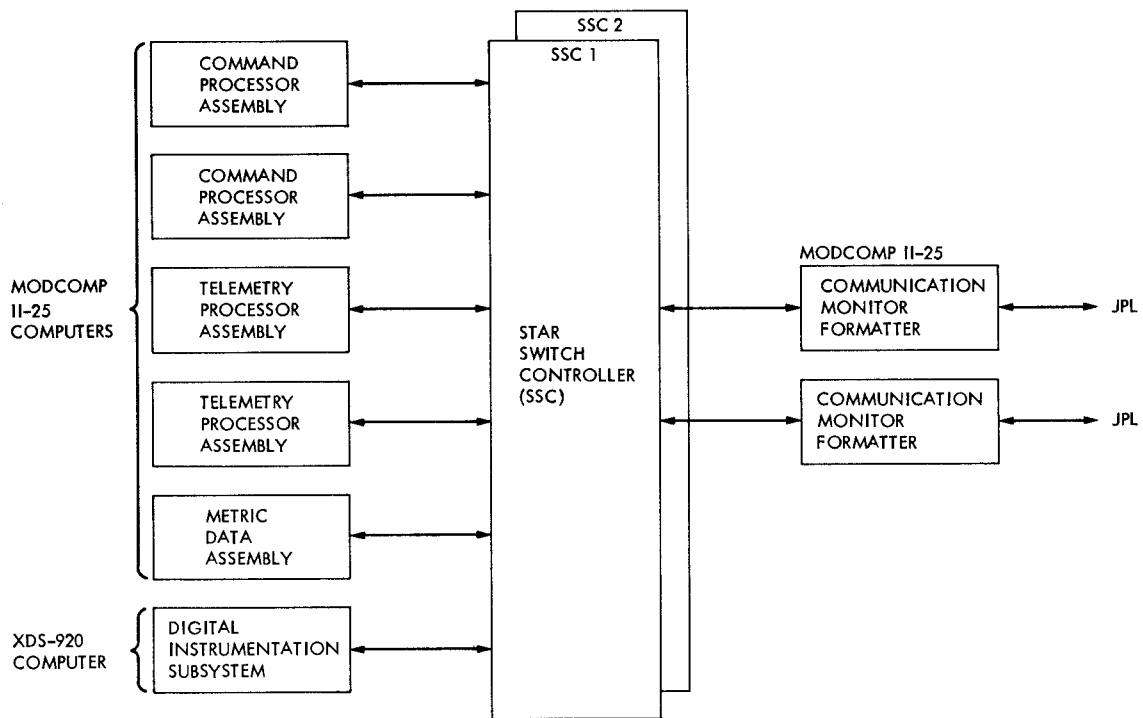
Fig. 2. Deep Space Station Star Switch Controller-computer configuration, Mark III-77

CMF – COMMUNICATIONS MONITOR FORMATTER ASSEMBLY
BMXR – BLOCK MULTIPLEXER
EDED – ENCODER DECODER
EDC – ERROR DETECTION CORRECTION ASSEMBLY
HSW – HIGH SPEED SWITCH ASSEMBLY
CCM – CENTRAL COMMUNICATIONS MONITOR ASSEMBLY
NOCC – NETWORK OPERATIONS CONTROL CENTER
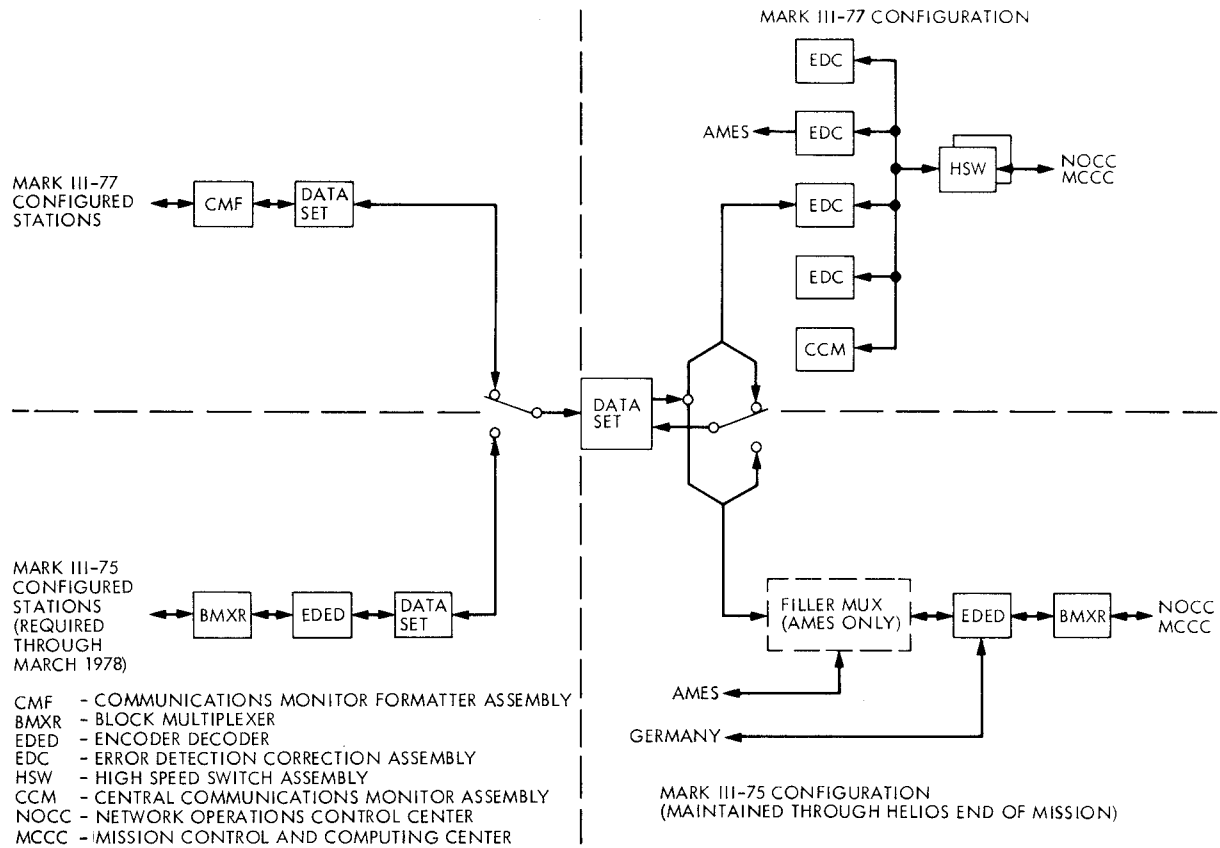MCCC – MISSION CONTROL AND COMPUTING CENTER

Fig. 3. GCF High-Speed Data Subsystem configuration (1976 through 1978)