DSN Command System Mark III-74

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A general description is presented of the DSN Command System software changes that are being implemented to support the Helios and Viking missions. Comparisons are made between the present system (Mark III-71) and the new system (Mark III-74). Included are the reasons for the changes, and the DSN plans to phase all mission support over to the Mark III-74 system.

I. Introduction

The DSN Multiple Mission Command (MMC) System has successfully supported the Mariner Mars 1971 (MM'71) mission and the Pioneer 10 mission to Jupiter. The system is now supporting the ongoing Pioneer 10 mission, the Pioneer 11 mission to Jupiter, and the Mariner Venus/Mercury 1973 (MVM'73) mission. All of these missions have been supported with the same DSN hardware.

The command software provided by the DSN in the Deep Space Stations' (DSSs) telemetry and command processors (TCPs) has been basically the same from mission to mission. The command requirements for each mission have been similar, and thus the software has remained basically the same as that designed for the MM'71 mission (hereafter referred to as the DSN Mark III-71 Command System).

The DSS TCP is an XDS 920 computer. The DSN implemented the DSS telemetry and command functions into this computer for all the missions. One of the primary problems in implementing the command portion of the software was timing. These timing problems had to be overcome in the software used during the Mark III-71 era. All the missions supported during this era required the same transmission rate (1 bit/s); thus, the software timing considerations were similar.

The DSN is presently implementing significant changes in the DSN MMC System (the DSN Mark III-74 Command System). The Helios and Viking mission command transmission rates are 8 symbols per second (SPS) and 4 bits/s, respectively. The software timing considerations are significantly increased over those missions supported during the Mark III-71 era. For this reason, the Command System is undergoing extensive software changes.

II. Mark III-74—Command System Changes

A. Transfer of System Functions

The increased command transmission rates from the Mark III-71 to the Mark III-74 era have made it necessary to transfer some command functions from the DSS TCP to the Mission Operations Center (MOC). Figure 1 shows a simplified block diagram comparison of the Mark III-71 and the Mark III-74 Command Systems. One of the prime time-consuming functions provided by the TCP in the Mark III-71 System was command stack manipulation. The TCP sorted, arranged, and searched the command stack frequently for the Mark III-71 System. The Mark III-74 System has transferred these functions to the MOC.

B. MOC Software Changes

In the Mark III-71 Command System, the MOC software basically provided a remote terminal capability to the TCP. Under operator control, the MOC software generates high speed data (HSD) blocks of command data. The data are transmitted to a DSS TCP, where they are placed in the TCP command stack. A verification block is returned, and the MOC performs a bit-by-bit comparison with what was transmitted. Failure to verify results in automatic retransmission of the command block. An enable block is generated, either automatically after successful verification or under operator control, and transmitted to the DSS TCP. Again a verification block is returned, and the MOC software performs a bit-by-bit verification on the enable block. After successful transmission of the command from the DSS to the spacecraft, the TCP constructs a command confirmation HSD message and sends it to the MOC. The MOC software displays the command confirmation to the operator.

In the Mark III-74 Command System, the MOC software provides direct control of the contents of the TCP command stack. The operator controls the contents of the command queue in the MOC. The MOC software then can, via HSD messages, force the TCP stack contents to be consistent with the command queue in the MOC. Under operator control, commands are entered into the command queue. When the operator enables commands in the queue, the commands are "eligible" for transmission to the DSS TCP. The commands are sent to the DSS TCP and placed in the TCP per direction in the HSD message. An acknowledge message is constructed at the TCP and sent to the MOC. The data are compared against the contents of the queue. Failure to compare results in automatic retransmission to the TCP. After successful transmission of a command from the DSS to the spacecraft, a message is sent from the TCP to the MOC. The MOC compares this message with the contents of the queue. The command is then marked "successfully confirmed" and displayed to the operator.

The basic changes to the MOC software are the command queue concept and the ability to directly control the contents of the TCP command stack.

C. TCP Software Changes

In the Mark III-71 Command System, the TCP sorts, arranges, and searches the commands in the command stack. Upon receipt of commands from the MOC, the TCP software sorts priority and timed commands into basically two stacks. When enable messages are received from the MOC, the TCP software is required to search the complete stack to ensure proper command enabling. When interrupts (every bit time) are received that tell the software that the hardware is ready to transmit the next command, the complete stack is searched in an attempt to find a command that is eligible (enabled and/or timed) for transmission.

In the Mark III-74 Command System, the TCP software is no longer required to arrange and search the TCP command stack. The MOC software is required to keep the stack in logical order such that the TCP only has to "look" at the top command in the stack. The TCP stack is arranged into four modules and an active register. The stack is loaded by module via HSD block from the MOC. The MOC software is required to keep the stack modules updated consistent with the command queue in the MOC. The only command eligible for transmission to the spacecraft is the top command in the number one module. Note that an enable message is no longer required from the MOC. There are two types of commands in the Mark III-74 System: (1) timed commands, and (2) nontimed commands. A nontimed command will be transmitted immediately when it occupies the top command in the number one stack module. A timed command will be transmitted when the GMT reaches the command transmit time and the command occupies the top command in the number one stack module. The command is transmitted to the spacecraft by "moving" it to the active register. Upon successful transmission of the command from the DSS to the spacecraft, a HSD message is constructed by the TCP and sent to the MOC for notification of confirmation.

The primary change to the TCP software for the Mark III-74 System is the deletion of stack arranging and searching. This has allowed the capability for the

software to perform more important functions at the higher command bit rates. The same types of hardware checks provided at 1 bit/s for the Mark III-71 System can be provided for the Helios command rate of 8 SPS.

III. Mark III-74 Command System—Mission Support Plans

It is desirable from an operational and sustaining engineering viewpoint that all missions supported by the DSN be supported by the same DSN Command System. An operational consideration is that two-system operation can lead to confusion when different characteristics exist. Another operational consideration is that personnel training is simplified when one system is used. The sustaining engineering consideration is, of course, less cost. For these reasons, the DSN plans to phase all mission support over to the Mark III-74 Command System. The present plans for phase-over of all support is shown in Table 1. All missions will be phased over after critical events are complete. The Helios and Viking test periods and flight operations will be supported entirely by the Mark III-74 Command System.

Table 1. Mission support phase-over plans to the Mark III-74 command system

Mission	Test period	Flight operations
MVM'73	May–June 1974	July 1974
Pioneer 10	January–August 1974	September 1974
Pioneer 11	Same as Pioneer 10	January 1975

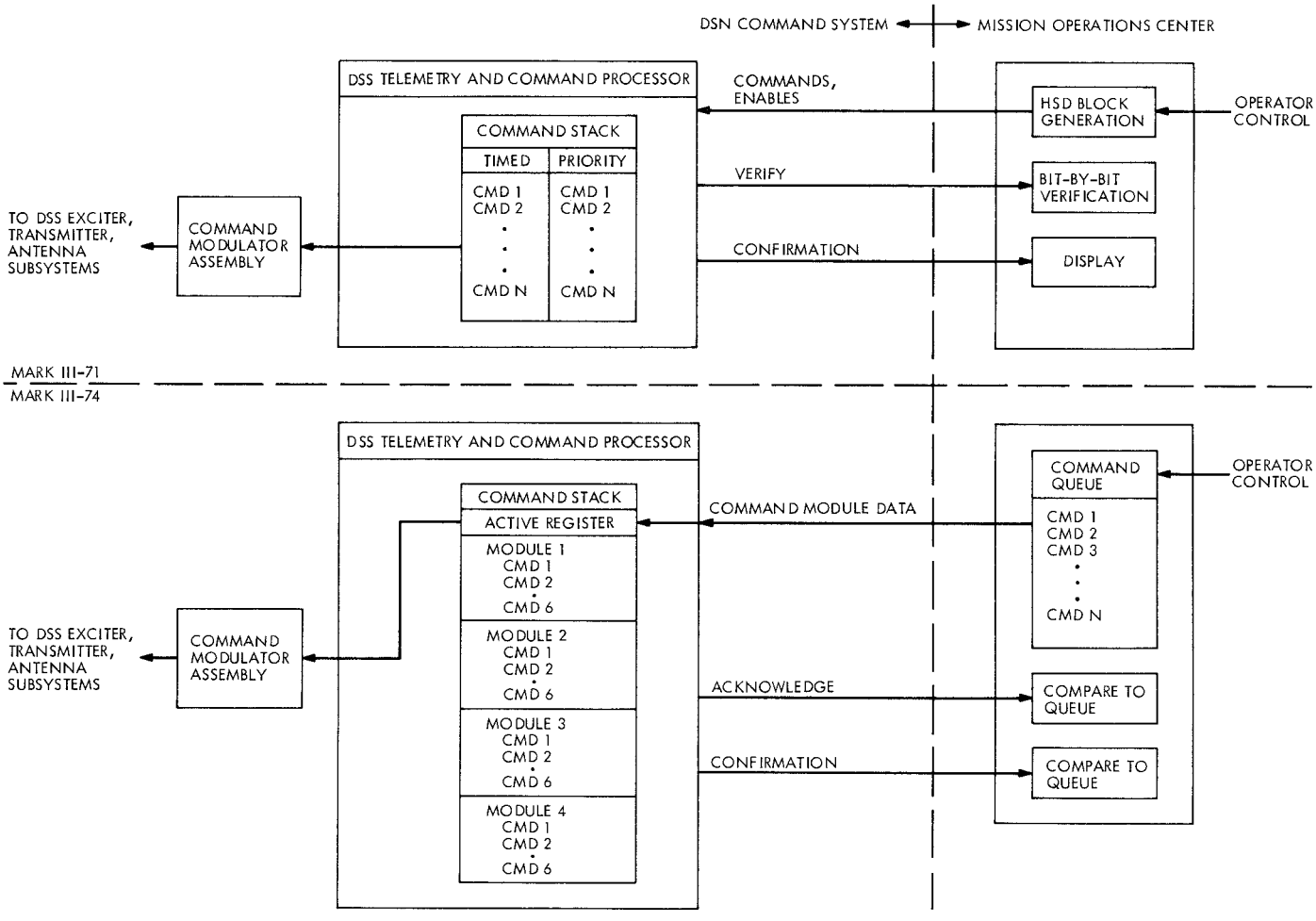

Fig. 1. Comparison of Mark III-71 and Mark III-74 command systems