Automatic Total Recall Program for Replay of DSN 7-Track DODRs

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The requirement exists for the capability to obtain as complete and accurate a record as possible of all high-speed data communication between the mission control center and the DSN ground stations in support of deep space mission operations. The Automatic Total Recall System was designed and developed for that express purpose. This article describes the functional aspects of the software operating in that system.

I. Introduction

The Deep Space Station (DSS) Telemetry and Command Subsystem (TCD) supports deep space mission operations by providing a data detection and processing capability, which in operation with the Ground Communications Facility (GCF) provides a communications link between the spacecraft and the mission control center. The TCD is responsible for transmitting commands to the spacecraft and for recovering incoming telemetry from the spacecraft. In performing mission support functions, the TCD generates a real-time log of all telemetry and command data transmitted over the high-speed data communication link between the DSS and the mission control center. The recording is on a 7-track magnetic tape directly connected to the Telemetry and Command Processor (TCP). The digital tape serves as the Telemetry and Command Digital Original Data Record (DODR) for the TCD.

II. Purpose

The purpose of the Automatic Total Recall System (ATRS) program is to provide automatic or manual capability for replaying to the mission control center the Digital Original Data Record (DODR) located at the DSS. The objective of the ATRS program is to create a complete master data record of spacecraft data, as free from error as possible.

The need for replaying the DODR arises from the possible presence of data outages occurring in high-speed data transmission between the DSS and the mission control center. The data outages may be the result of existing noise on the high-speed data lines or the complete loss of high-speed data communication due to a hardware malfunction. By providing the capability to replay the original data record, ATRS allows the mission control center to reconstruct a complete record of data transmission.

III. Program Structure

The ATRS program was developed and implemented on the TCP, an XDS 920 computer with 16K words of core memory. Associated with the TCP are two XDS 7-track high-density recorder tape transports capable of reading and writing information at 200 and 556 bpi. The program was implemented in assembly language and modularly structured to accommodate future expansion and facilitate maintenance operations. The program resides on magnetic tape and is loaded into the TCP by means of a paper tape bootstrap loader.

IV. Modes of Operation

The primary source of program input and control identifies the mode of operation. When the ATRS program is initially loaded and configured, the local DSS operator specifies the mode of operation as automatic or manual. In automatic operation, program input requests and control directives are issued by the mission control center by means of high-speed data transmission lines. The DSS remains in a passive state, observing and monitoring the remote inputs and the program status and summary reports generated during the data replay operation.

In the manual mode of operation, program control is retained at the DSS. Initialization and input request parameters are specified by the mission control center and are transmitted to the DSS by voice communication lines. The directives are then entered by the operator at the console keyboard device.

In either mode of operation, the destination and type of program output remains invariant. Output to the mission control center consists of recalled telemetry, command or monitor data transmitted along with accompanying status blocks by means of high-speed data lines. Output at the DSS is directed to the console typewriter and consists of the acknowledgment of remote inputs and the display of status and summary reports generated by replay processing.

V. Replay Process

ATRS expects to receive three types of program input: replay initialization, replay request and replay control directives. The content of program input is the same for both modes of program operation with only the input format varying. For automatic operation, replay parameters are formatted into 50-word high-speed data block images; for manual operation, the replay parameters are entered as uniquely defined text messages.

The initialization directives establish the overall time limits for a particular replay sequence and designate the type of data to be recalled. The data to be recalled are selected by specifying one or more user or data-dependent type codes.

The replay request directives establish the start and stop day specification and the begin and end time limits associated with a particular set of data outages. From one to 19 data gaps may be specified in each replay request directive.

The replay control parameters enable the user to interrogate and to exercise direct control over the program. Control directives permit the user to initiate, temporarily suspend, resume or terminate program operation, and to request the status associated with the last completed replay request or to request the program's current execution state.

When ATRS processing is initiated, the program proceeds to search the 7-track DODR mounted on the tape unit. Upon encountering a data record on the tape in which the time is equal to or later than the replay start time specified in the initialization directive, the DODR is considered to be properly positioned and a status block is transmitted to the mission control center indicating this condition. At this point the ATRS program is ready to process replay request directives. Upon receiving such a directive, the program sequentially examines each data gap specification and proceeds to read DODR records searching for the data associated with a particular data gap. The DODR records contain the exact images of five data blocks which were originally transmitted in real-time by the TCD Subsystem over high-speed data lines. Each block within the DODR record is examined to determine if the current block falls within the replay window identified by the data gap specification; if not, the block is bypassed and the next block in the record is tested. When the data block falls within the replay window, the program proceeds to test the block against the requested data type specification. If the data type criteria are satisfied, the block is transmitted over high-speed data lines to the mission control center.

When a replay request gap has been satisfied (i.e., when the last data block in the replay window has been located), a status block is sent to the mission control center. The status block contains the number of tape read errors encountered and the total number of DODR block transmissions initiated while processing the latest replay request gap. At the same time a message containing

similar status information is displayed on the DSS console typewriter.

The ATRS program has the capability to accept and process replay request gap specifications in which the start time is earlier than the time in the current DODR record. Such regressive time requests cause the DODR tape to backspace until the record time is compatible with the request time.

The Automatic Total Recall System program is capable of supporting the Pioneer, Helios and Viking missions. The program has the capacity to replay any DODR whose record and data block formats conform with the DSN System Requirements Detailed Interface Design.

Figures 1 through 3 provide information relating to program functions, data flow, and DODR record format, respectively.

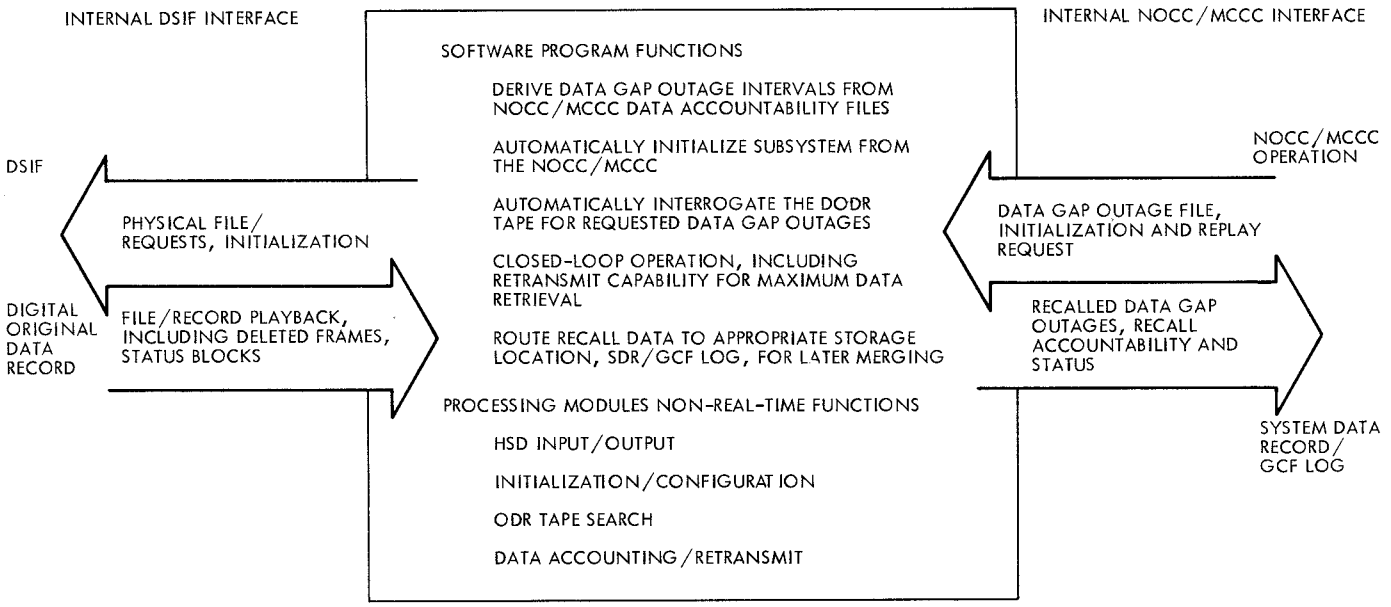

Fig. 1. Automatic total recall system functions

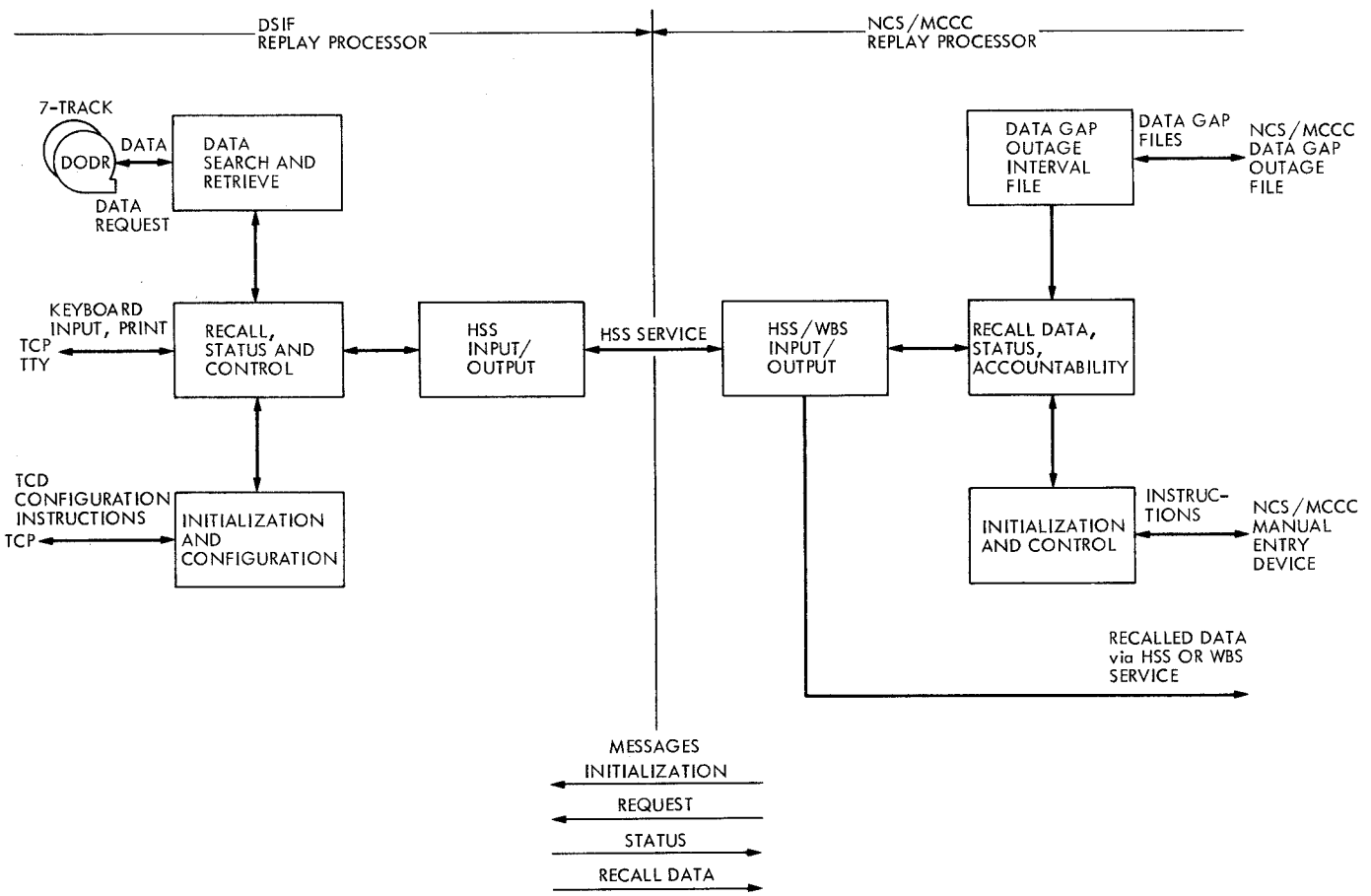

Fig. 2. Automatic total recall system data flow chart

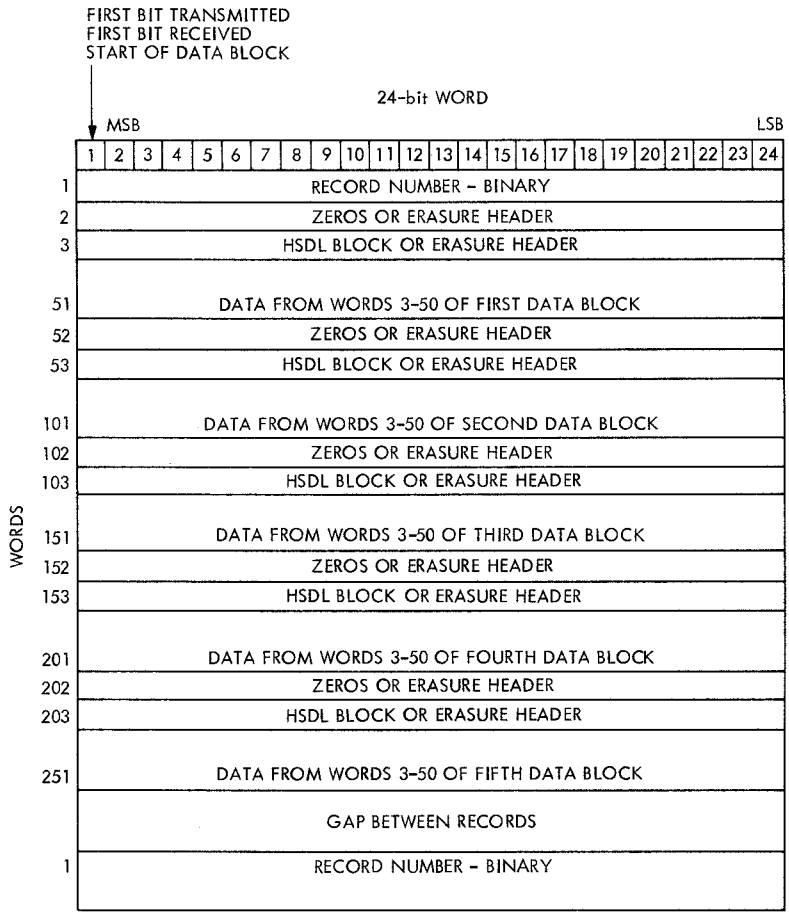

Fig. 3. TCP DODR record format, 1200-bit GCF blocks, 7-track, 200 or 556 bpi