Ground Communications Facility Functional Design for 1973-1974

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The Ground Communications Facility (GCF) 1973–74 capability, described herein, will be used to support Pioneer, Mariner Venus–Mercury 1973 (MVM73), and Helios operations, plus the early development and testing associated with the 1975 Viking project. The design includes a full spectrum of GCF capabilities for the overseas 64-m-diameter antenna stations. The wideband data system will be enlarged to cover all 64-m stations, plus CTA 21 and DSS 71. The standard wideband rate will be 28.5 kbps with limited use of 50 and 230 kbps for special purposes. The wideband block length will be increased to 2400 bits after MVM73. The number of teletype circuits will be reduced in keeping with the DSN's policy of eliminating this medium for computer-to-computer data transfer.

I. Introduction

The Ground Communications Facility (GCF) provides the ground communications capability required by the DSN for the conduct of space flight operations. This capability changes in an evolutionary manner to meet the constantly changing (generally increasing) communications requirements of the DSN.

This article discusses the general design of the GCF for the 1973–1974 era. The majority of the implementations required for this new capability will be completed by mid-1973. The capability outlined herein will be used to support the Pioneer 10, Pioneer G, MVM 73, and Helios 1974 operations. This capability will also support early development and testing associated with the 1975 Viking project.

The GCF consists of four systems: voice, high-speed data (HSD), teletype, and wideband (WB). Although each system provides a distinctly different capability, the systems share some terminal equipment and transmission circuits.

II. Transmission Capability

The GCF 1973–74 committable transmission capability is shown in Fig. 1. This capability will provide a basic allocation of one voice, one high-speed data, and two teletype circuits per DSS. Wideband data circuits will interconnect the SFOF with Deep Space Stations 14, 42/43, 61/63, 71, and CTA 21. The specialized MVM 73 project-

oriented requirements of Hangar AO and Boeing are depicted. Except for one teletype, the AO circuits will be activated only in support of launches and prelaunch testing, while the Boeing circuits will be turned up only for testing purposes in early 1973. The NASCOM Madrid Switch Center will be the circuit interface point for data exchange between the Mission Control and Computing Center (MCCC) and the Helios operational facilities in Germany. The circuits necessary for the traffic load will be provided between the Central Communications Terminal and the Network Control System (NCS). The composition of these circuits will vary depending on the NCS location.

Most of the GCF transmission capability is furnished by the NASA Communications Network (NASCOM) from a pool of circuits which it uses to satisfy all of NASA's long-haul tracking network communications requirements. The communications capability of the GCF ebbs and flows as requirements change and is seldom constant from day to day. The capability shown in Fig. 1 represents the circuit quantities used for terminal equipment design purposes. Although circuit quantities may change quickly, the highly specialized terminal equipment is permanently installed and has a relatively lengthy development and implementation cycle. The transmission capability shown in Fig. 1 is not exhaustive. The GCF provides many circuits to other locations too numerous to depict herein.

III. Voice System

The GCF voice system for 1973–74 will be functionally the same as the present system. Voice circuits are shown on Fig. 1 although this figure does not include NASCOM west coast switch circuits.

Tactical intercom assemblies for DSS 43 and DSS 63 will be installed at these new stations, and tactical intercoms will replace the STDN-supplied equipment at Stations 11, 42 and 61. Voice circuits will be installed between the NCS and the Central Communications Terminal, and an internal NCS voice capability will be implemented. During noncritical periods, all overseas Deep Space Stations supporting a particular project will normally be combined on a single net. Independent circuits to each DSS will be provided during critical periods, NASCOM resources permitting.

IV. High-Speed Data System

The general configuration of the GCF 1973–74 high-speed data capability at the Central Communications Terminal (CCT) (JPL Bldg. 230), the 26-m stations, CTA 21, and DSS 71 will be as shown in Fig. 2. In comparison with the present configuration, this configuration has been changed as follows:

(1) The Central Communications Terminal high-speed capability has been increased to accommodate eight HSD streams instead of the six formerly available. These extra channels are now accommodating the joint MM71/Pioneer needs.

(2) The three channels of the HSD equipment in the Simulation Center will be relocated to the Central Communications Terminal, thus increasing the CCT capability to 11 channels.

(3) Two new additional channels may be installed in the CCT to raise its capability to 13 channels total in support of MVM 73, Pioneer F and G, and Helios.

(4) The simulation conversion assembly/antenna pointing subsystem (SCA/APS) computer transmit channel will be connected to an existing block multiplexer (BMXR) input port at DSSs 11, 42, and 61.

The Central Communications Terminal will be modified to interconnect the Network Control System (NCS) to the Deep Space Stations and Office of Computing and Information Systems (OCIS)/Project locations. The nature of the modifications will be reported later.

The HSD configuration at DSSs 14, 42/43, and 61/63 is shown in Fig. 3. This configuration, which is substantially different from that at the 26-m-diameter antenna stations, provides for two operational HSD circuits, with dual BMXRs, error detection encoder-decoders (EDEDs) and data sets. Dual circuits will connect each location to its area switch. A monitor interface unit will also be provided at all 64-m station locations.

The new BMXR selector will permit any of the Deep Space Station computers to be connected to any of the operational or backup block multiplexers. The BMXRs will continue to provide four input ports; thus not all of the computers may be simultaneously connected to the same HSD line. Barring this limitation, complete switching flexibility will be provided.

The block demultiplexer selector, a new device, will permit any of the block demultiplexer (BDXR) output ports to be connected to any of the DSS computers. Full switching flexibility will be provided. However, this selector will include provisions against accidental connection of two BDXR ports to the same computer input channel.

No provision will be made in this device to permit one BDXR port to drive two computer input channels.

The high-speed data assembly at all Deep Space Stations will be structured so that a conventional audio loop-around will be possible at the line side of the data sets. These loop-around capabilities will aid station prepass checkout.

The high-speed data block size will continue to be 1200 bits long. Circuit speed will remain at 4800 bps. However, all future HSD equipment and interfaces (except data sets) will be designed to operate at rates up to 9600 bps.

The HSD system will have an end-to-end (DSIF-JPL/CCT) long-term uncorrected bit error rate of 6×10^{-5} or lower. On a long-term basis, 98% of all blocks will be delivered error free. (Of the remaining 2%, nominally up to 1% may be delivered with known transmission errors, and up to 1% will either not be delivered or will not be properly identified.)

V. Teletype System

The 1973–74 GCF teletype system will typically provide only two (instead of four) teletype circuits per station (Fig. 1). These 100-wpm circuits will carry very limited traffic: OPS-X (operational teletype) messages, conferences, and administrative messages. The DSS teletype circuits will not be used for telemetry, command, monitor, or simulation data. Tracking data will be phased off teletype during this period. During 1973–74 the GCF will continue to deemphasize teletype for operational traffic with the ultimate aim of reserving teletype as a medium for administrative traffic only. Teletype will not be interfaced to the NCS. The existing Communications Processor will provide the necessary teletype switching and OCIS computer interfacing. Plans will be developed during this period to phase out the Communications Processor.

For teletype west coast switching purposes, the Central Communications Terminal will continue to provide the JPL end of a 32-channel voice-frequency telegraph group (VFTG) configuration, plus interconnections for up to 30 teletype drops in the western area of the U.S.

The teletype interconnections to the DSIF telemetry and command processor assemblies (TCPs) and digital instrumentation subsystem (DIS) will be removed when the third and fourth station teletype circuits are removed. Each control room at the joint 26/64-m stations will be provided with teletypewriter (TTY) machines which can be connected to any of the SFOF teletype circuits serving the joint station.

VI. Wideband System

The current (1971–72) wideband data capability operates at 50 kbps, interconnecting the CCT with DSS 14 and CTA 21. A terminal in the Simulation Center permits simulated data to be forwarded to DSS 14, CTA 21, or the mission and test computer (MTC). Incoming telemetry data from CTA 21 or DSS 14 are normally routed to the MTC. The present wideband data terminals accept and process standard 1200-bit data blocks, using standard high-speed data error detection encoder/decoder, block multiplexer, and demultiplexer units.

The wideband data capability for 1973–74 will be as shown in Fig. 4. In this interval wideband data will interconnect the SFOF to DSSs 14, 42/43, 61/63, 71, CTA 21, and a single project location at Hangar AO, Boeing, etc. As in the current system, JPL will provide the circuits between the SFOF and CTA 21 and DSS 14. NASCOM will provide the DSS 42/43, 61/63, 71 and project-location circuits. All of the OCIS/Project wideband data interfaces in Building 230 will be at the CCT. The basic wideband data capability will operate at 28.5 kbps in support of MVM 73 and Viking. The DSS 14 regular link will later be upgraded to 50 kbps to meet Viking needs at that location. Additionally, a short-period 230-kbps circuit will be installed from DSS 14 to the JPL CCT to accommodate an MVM 73 Venus encounter data rate of 117 kbps.

A new device, the coded multiplexer, will accomplish the equivalent functions of a block multiplexer, error detection encoder, error detection decoder, and block demultiplexer. This device will be much smaller and less costly than the four individual units and will be capable of operation at 250-kbps or higher rates. The device will include self-test features and the capability of loop-around testing. Separate monitor outputs will denote loss of signal, search, block error, etc. The coded multiplexer will accommodate block lengths of 1200, 2400, and 4800 bits.

The standard wideband data block length will remain 1200 bits long through MVM 73 and will then shift to 2400 bits in preparation for Viking. The DSN Network Control System will interface the wideband system in the JPL CCT. Additionally, wideband circuits may also be used to interconnect NCS elements. Details of such interfaces and usage will be reported at a later date.

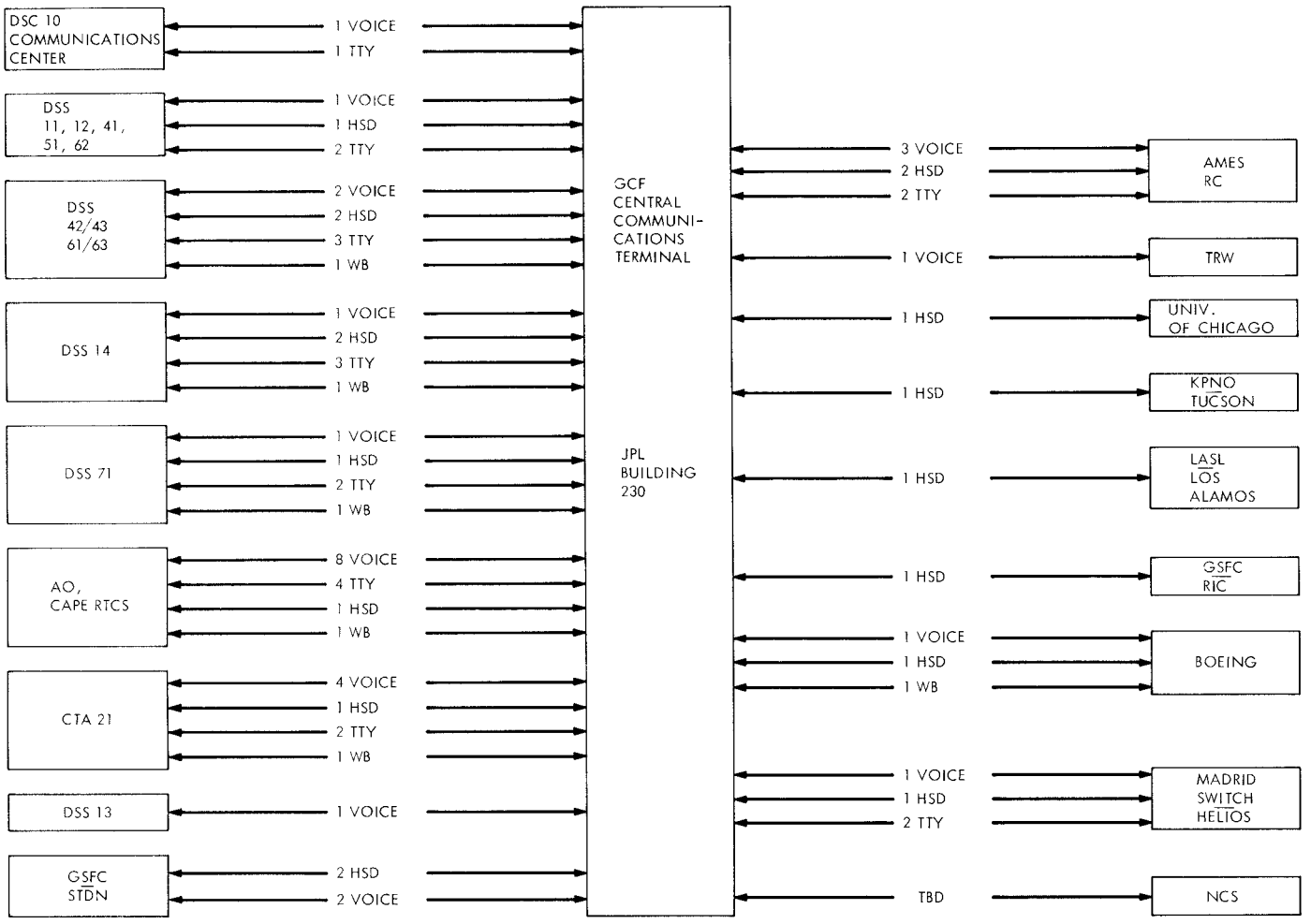
The long-term (several-hour) end-to-end (DSIF-CCT) bit error rate will be 5×10^{-5} or lower. Of all of the 1200-bit wideband data (WBD) blocks handed over to the GCF for transmission, 97% will be delivered error free. (Of the remaining 3%, nominally up to 1% will be delivered with errors, and up to 2% will either not be delivered or will not be properly identified.)

VII. West Coast Switching

In support of NASCOM, the GCF provides and operates the West Coast Switching Center for voice, teletype, and high-speed data circuits. Permanent circuits radiating out from Pasadena to many NASA/contractor locations are switched (on a scheduled basis) to long-haul trunks extending to the NASCOM Central Switch at the Goddard Space Flight Center in Greenbelt, Maryland. This west coast switch permits a relatively few cross-country trunk circuits to satisfy the needs of numerous individual users in the western U.S. The same GCF equipment is currently used to switch both DSN and west coast traffic, thus providing further economies.

VIII. Reliability

In 1973–74, each traffic path through the end-to-end GCF (except WBD) will have a critical period long-term availability of not less than 0.99 during any scheduled usage period, measured after data flow is established. WBD will have an availability of 0.98 on the same basis as above. The critical-period mean-time-to-restore (MTR) any service except WBD will not exceed 15 min. No MTR is specified at this time for WBD.



ALL STATIONS SUPPORTING A PARTICULAR PROJECT WILL NORMALLY BE CONFERENCED ON A SINGLE SHARED VOICE NET. MULTIPLE VOICE CIRCUITS, AS SHOWN, WILL BE USED ONLY DURING CRITICAL PERIODS.

Fig. 1. GCF 1973–74 transmission capability

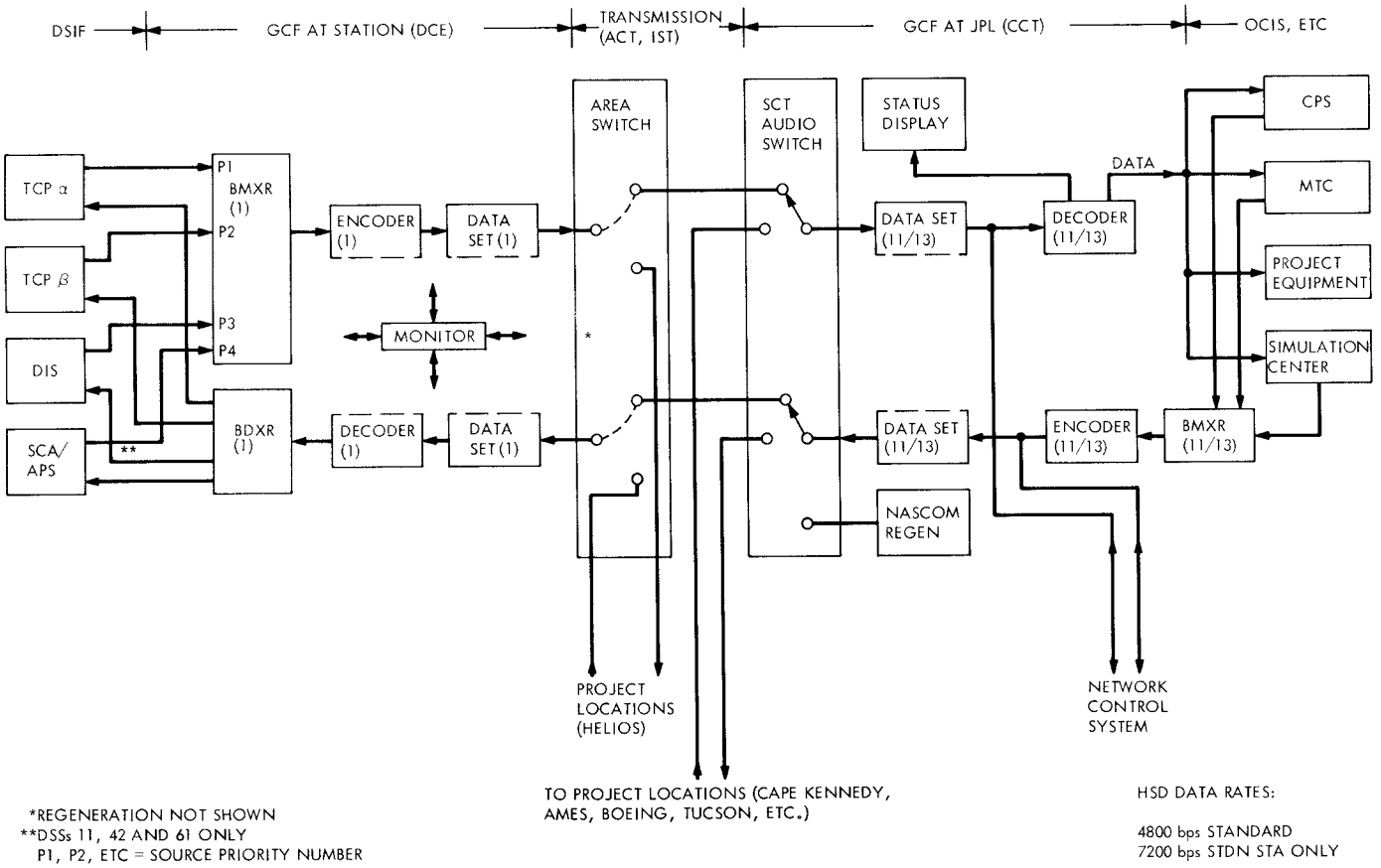


Fig. 2. GCF 1973–74 high-speed data system, 26-m DSS and central capabilities

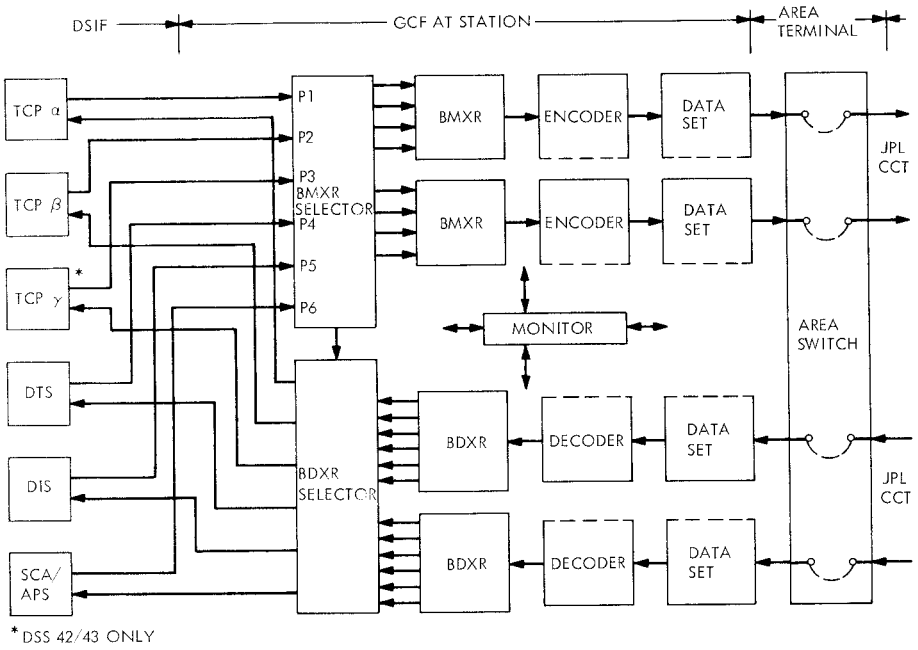


Fig. 3. GCF 1973–74 high-speed data system, colocated (26/64-m) and 64-m DSS capabilities

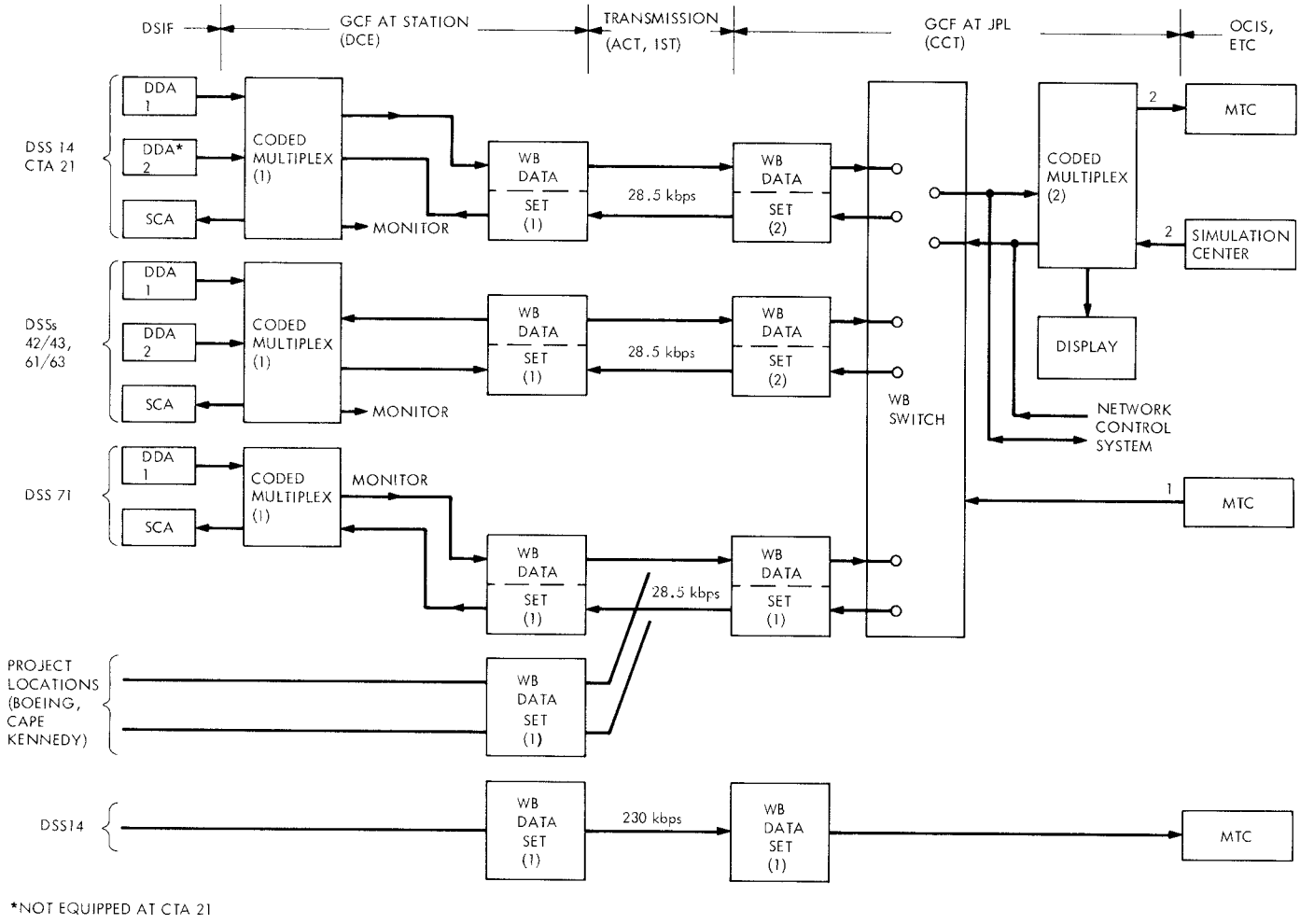


Fig. 4. GCF 1973–74 wideband data capability