Network Control System Block I and Block II Software

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The Network Control System (NCS) software implementation for Block I and Block II involves two distinct multicomputer systems. NCS Block I is a three-computer system; NCS Block II is a five-computer system. While completely separate, these two systems will operationally complement each other to provide required NCS operational support until NCS Block III is implemented. Both systems are presently designed and coded and are under NCS testing. NCS Block I will be available for operational testing July 1, 1974. This will not include the capabilities for sequence of events generation, and tracking predicts generation. Both programs are scheduled for operation at a later date. NCS Block II will be available for operational testing in early September 1974.

I. Introduction

The Network Control System (NCS) software development is divided into three major implementations, Block I, Block II, and Block III. This report will describe software implementation status for Block I and Block II.

The Network Control System Block I is basically a three-computer system implemented to:

(1) Receive and provide accountability for high-speed data blocks (HSDBs) transmitted by Deep Space Stations (DSSs) to the Jet Propulsion Laboratory (JPL).

(2) Transmit and display command data utilized in the configuration and control of DSSs.

(3) Format and transmit to selected DSSs:
   (a) Sequence of events (SOE) files.
   (b) Seven-day schedules.
   (c) Tracking predict data.
   (d) Telemetry predict data.

(4) Generate for formatting:
   (a) Seven-day schedules.
   (b) Sequence of events.
   (c) Tracking predict data.

(5) Provide printer dump of selected data being transmitted by the DSSs to JPL and from NCS to the DSSs. This includes wideband data being received in either 1200- or 2400-bit block size.

The NCS Block II is a five-computer system implemented to:

(1) Receive and provide accountability for high-speed data blocks transmitted by Deep Space Stations to JPL.

(2) Provide sufficient HSDB data analysis to assure meaningful displays for operational support in the areas of telemetry, tracking, command, and monitor.

(3) Provide operational status of NCS Block II to a level that will readily identify major system operational problems.

The NCS Block I hardware configuration is shown by the simplified block diagram in Fig. 1. For a more detailed description of NCS Block I hardware configuration see Ref. 1. The NCS Block II hardware configuration is shown by the simplified block diagram in Fig. 2.

II. Block I NCS: System Operation and Software Capabilities

Six high-speed data lines are linked through the Ground Communications Facility (GCF) to the PDP-8 communications processor. All data, and Block I status information, are transferred via a 50-kb wideband data line to the Sigma-5 (Σ-5) real-time processor. Wideband data are received on a seventh channel by the PDP-8. Wideband blocks are multiplexed with regular high-speed data when a wideband data dump request is made. This is done by an operator at either Block I real-time cathode ray tube/keyboard (CRT/KB) display unit.

If the prime PDP-8 fails, the backup PDP-8 may be connected to the real-time Sigma-5 (B) or the backup PDP-8 and Sigma-5 (A) may become the new real-time string. If Sigma-5 (B) fails, either PDP-8 may be connected to Sigma-5 (A) as the new real-time system.

The formatting and generation of data are accomplished on whichever Sigma-5 is designated the non-real-time processor. After data blocks are formatted for transmission and recorded on 9-track magnetic tape, the recorded file or files are loaded on the real-time Sigma-5. The transmission blocks are stored on the real-time Sigma-5 disk until required for transmission. Files being transmitted, or, in the case of command data, single blocks, are transferred to the PDP-8 via the 50-kb data line and transmitted to the proper high-speed data channel. No wideband data blocks are transmitted in Block I or Block II.

The real-time Sigma-5 peripherals are utilized as follows:

(1) Only the 9-track magnetic tape units are used. They are used to load files for transmission. Initially, one of the 9-track units is used to load the program or, in the case when recovery is impossible from the disk, to reload the program for reinitialization.

(2) The line printers provide dumps of high-speed data and wideband data blocks. Command blocks are output in special formats. Special summary requests result in accountability printouts.

(3) The card reader is not used with the real-time system software.

(4) The teletype (TTY) devices provide a low-speed log of system performance and operator control.

(5) The CRT/KB consoles are the dynamic display points. Two formats are available to the operator. One is for real-time accountability and status. The second shows transmission file status. All operator inputs are typed on these keyboards. No entries are made via the TTY.

(6) The disk is used to store transmission files and maintain recovery files.

The non-real-time peripherals are used as in a normal batch processing environment. The CRT/KB and the communication link to the PDP-8 are not utilized. For a more detailed description of the data processing features of NCS Block I see Ref. 2.

The software module diagram for the PDP-8 internal interface is shown in Fig. 3. The Sigma-5 real-time software module diagram and all existing interfaces are shown in Fig. 4. The non-real-time module structure is shown in Fig. 5. For a detailed description of these modules see Ref. 3.

III. Block I NCS Status

The PDP-8 software has been operating in its basic form in Block I, Phase I and Phase II. The Block I, Phase III version allows both 1200- and 2400-WBD-block

dumps and is ready for acceptance testing and transfer to operations.

The Block I, Phase III real-time Sigma-5 software is functionally complete and tested. All Block I real-time capabilities are ready for acceptance testing with Phase III. This includes all real-time transmission capabilities, with extensions of long-term storage for high-speed transmission data to 5000 blocks from 3000 blocks in Phase I and Phase II.

The Block I, Phase III non-real-time system is ready for acceptance testing. All Block I functional capabilities exist except:

(1) SOE generation.

(2) Tracking predicts generation.

The SOE generation program interface has been under evaluation by DSN operations, DSN systems, and NCS implementation personnel. Design of the SOE program is underway, and transfer to operations is scheduled for early November.

The tracking predicts generation program is being implemented by the Tracking and Orbit Determination Section, Section 391. When the Sigma-5 version of the program is available, NCS implementation engineers will help integrate the program into the present non-real-time system.

IV. Block II NCS: System Operation and Software Capabilities

Six high-speed data lines are linked through the Ground Communications Facility (GCF) to the NCS Ground Communications Processor (GCP). The GCP then distributes the high-speed data blocks, via the Star Switch Controller (SSC), to the Real-Time Monitors (RTMs). This distribution is DSS subsystem oriented. There are four RTMs, tracking, telemetry, monitor, and command. All four RTMs are receive-only subsystems. No data blocks are transmitted from NCS Block II.

The RTM peripherals are utilized as follows:

(1) Character printer/keyboard (CP/KB). This unit provides a running diagnostic record of subsystem activity.

(2) Cathode ray tube/keyboard (CRT/KB). These units, two per subsystem, are the active display devices. The keyboards provide for operator control of subsystem activity. Active alarm conditions are displayed at the CRT/KB.

(3) Low-speed printer (LSP). The low-speed printer is actually another (CP/KB) used to log command activity. The Block II command RTM will log all incoming command blocks including confirmation data.

The GCP software module diagram is shown in Fig. 6. The generalized Real-Time Monitor (RTM) software module diagram is shown in Fig. 7. Detailed descriptions of how these elements function may be found in Ref. 4.

V. Block II NCS Status

The detailed design has been completed and approved for NCS Block II. The GCP has been receiving and distributing data over the SSC since May 1, 1974. Integration of the command and monitor RTMs was begun May 17, 1974. Test high-speed data blocks were transferred via the GCP to the monitor subsystem on June 7, 1974. Tracking and telemetry RTMs are scheduled for integration the first week in July. Both these subsystems are considerably more complex than the monitor or command RTMs. Integration should be accomplished smoothly since common modules and system interfaces will have been integrated and verified well before that time. Acceptance testing should be completed in early September 1974.

References

1. Frey, W. C., "Network Control System Development," in *The Deep Space Network Progress Report,* Technical Report 32-1526, Vol. XV, pp. 167–176. Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1973.
2. Renzetti, N.A., "Data Processing Capabilities of the Network Operations Control Center As Implemented by Block I Network Control System Project," DSN Capabilities Document 890-39, Jet Propulsion Laboratory, Pasadena, Calif., June 1, 1974 (an internal document).
3. Block I Detailed Design Document, Phase III, Network Control System (NCS), SD509758, Jet Propulsion Laboratory, Pasadena, Calif. (an internal document).
4. Network Control System Block II, Baseline Detailed Specifications, ES509271, Rev. A, April 25, 1974 (an internal document).

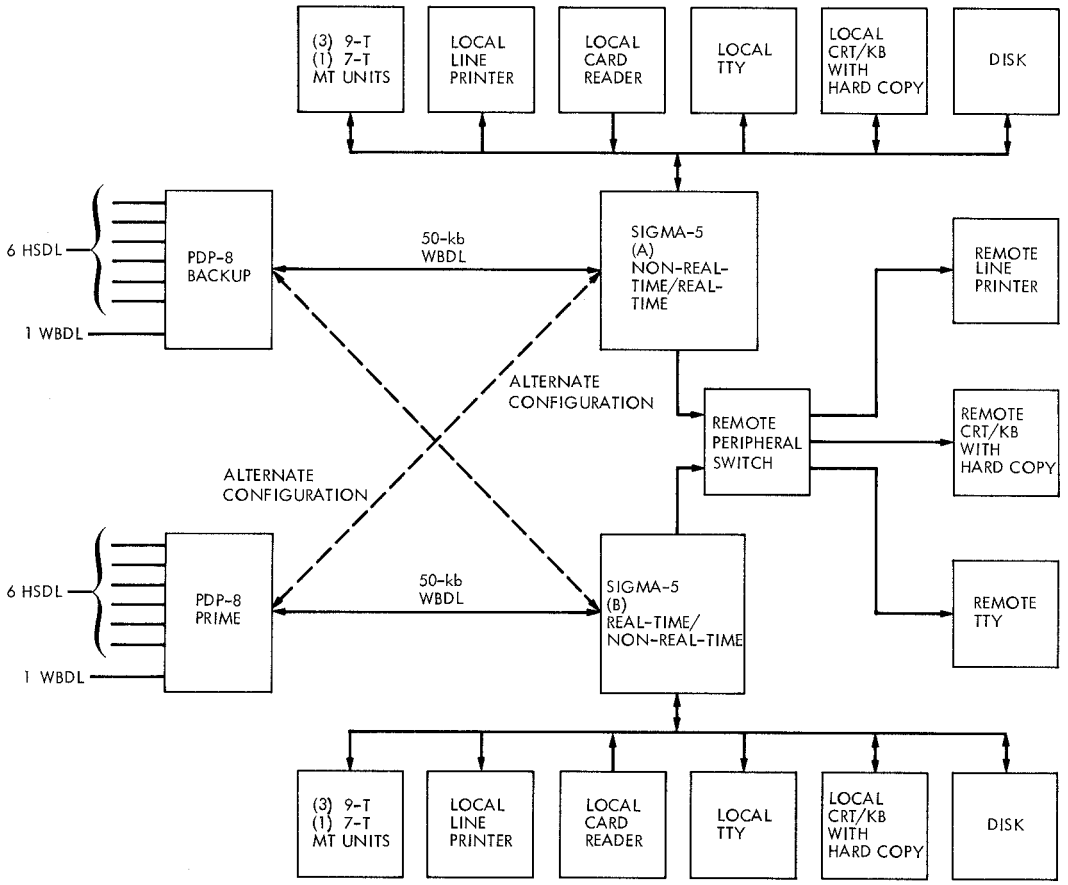

Fig. 1. Network Control System, Block I configuration

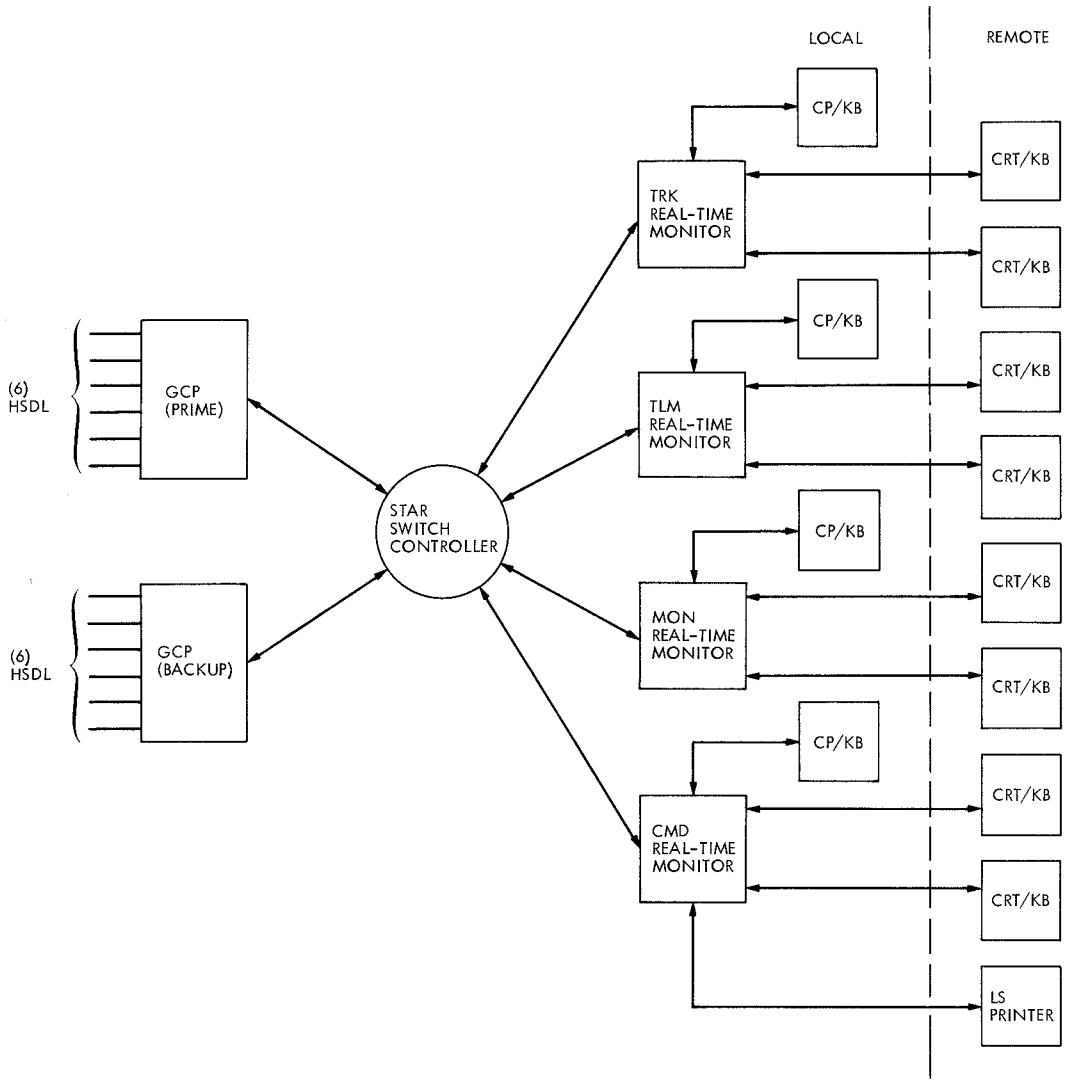

Fig. 2. Network Control System, Block II configuration

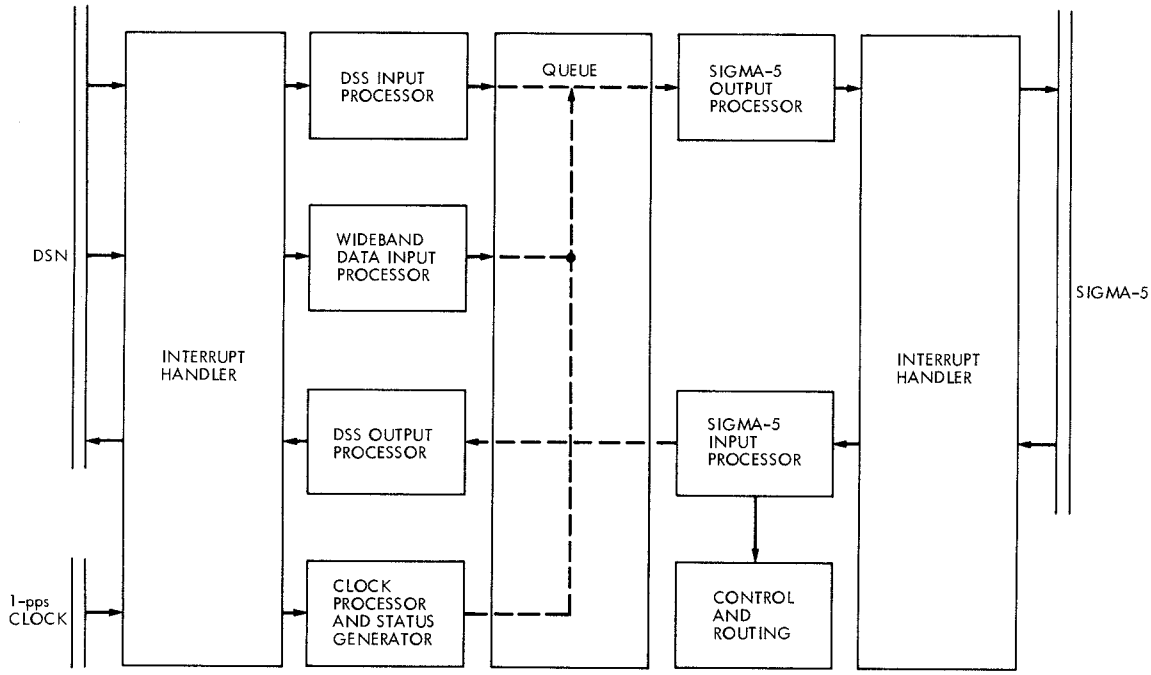

Fig. 3. Network Control System, Block I, PDP-8 software module diagram

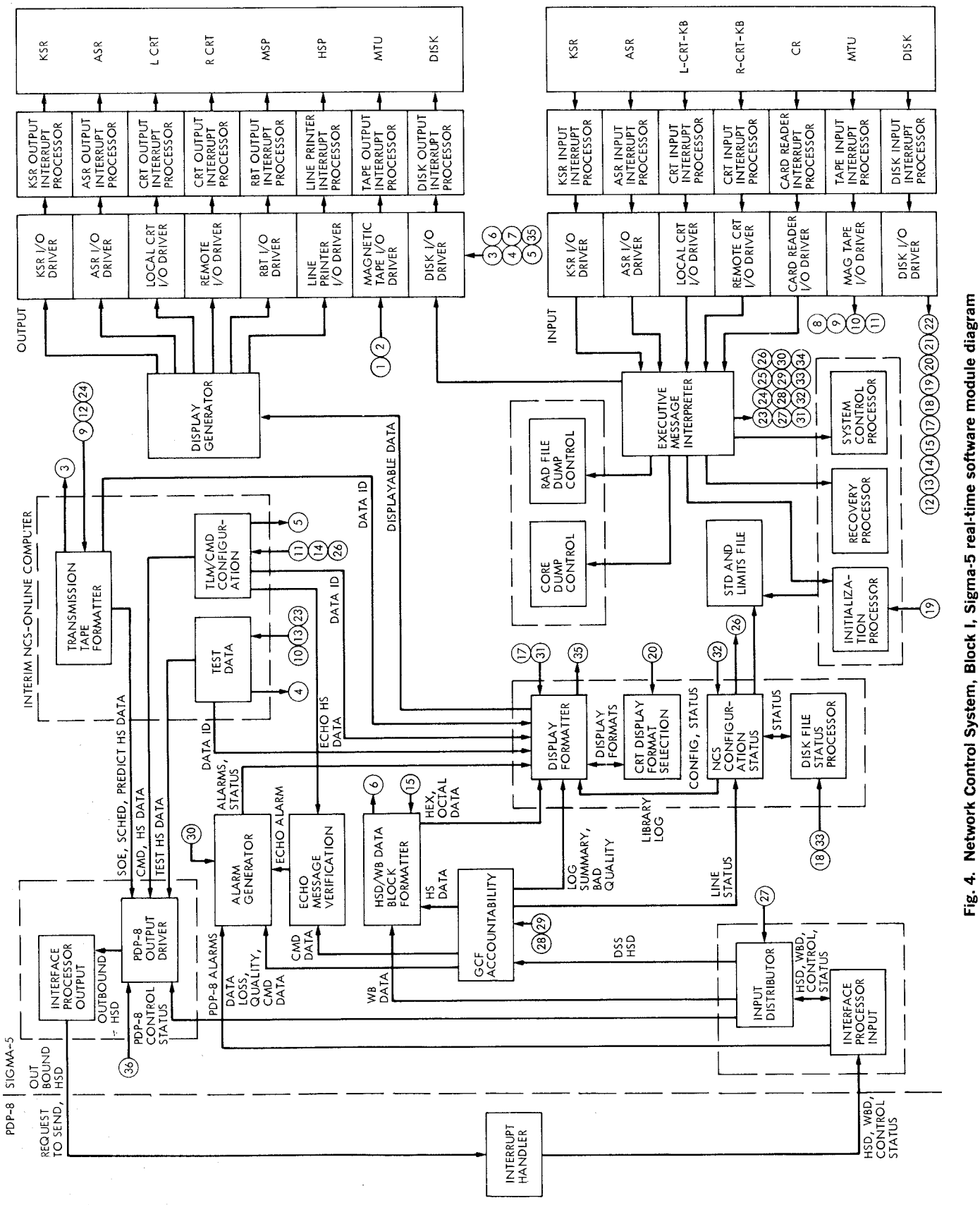

Fig. 4. Network Control System, Block I, Sigma-5 real-time software module diagram

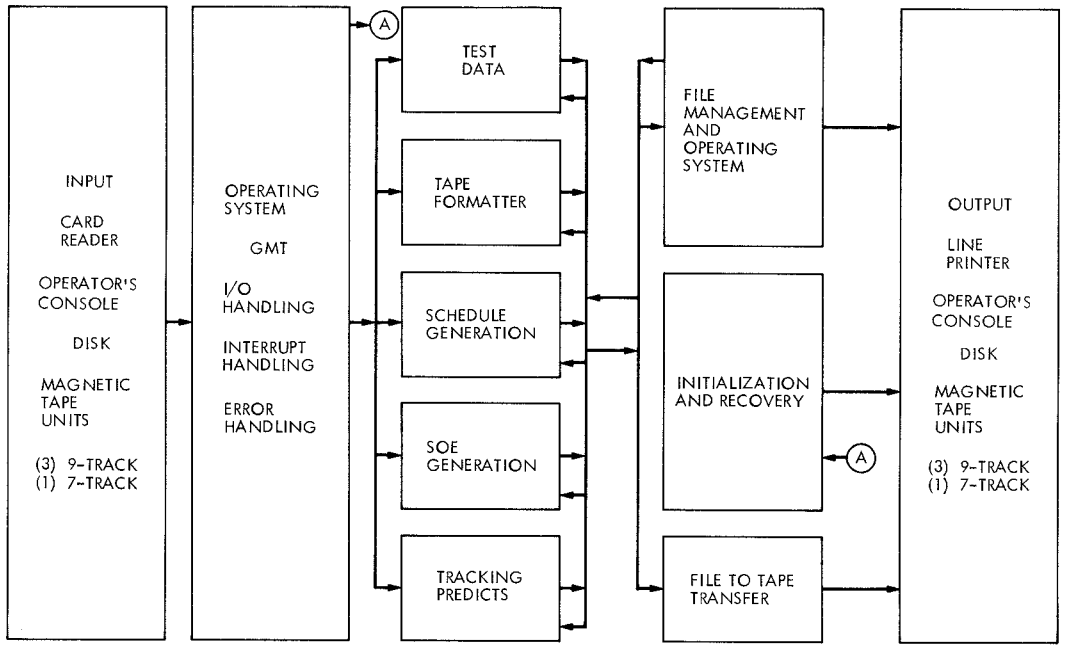

Fig. 5. Network Control System, Block I, Sigma-5 non-real-time software module diagram

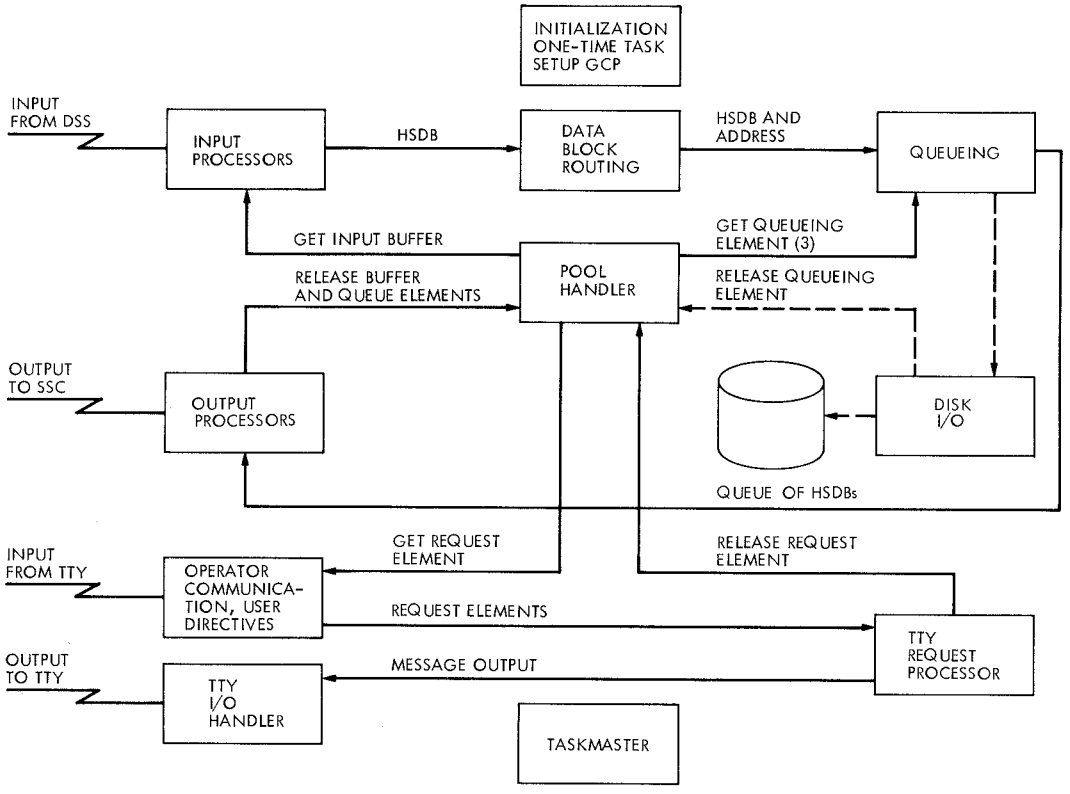

Fig. 6. Network Control System, Block II, GCP software module diagram

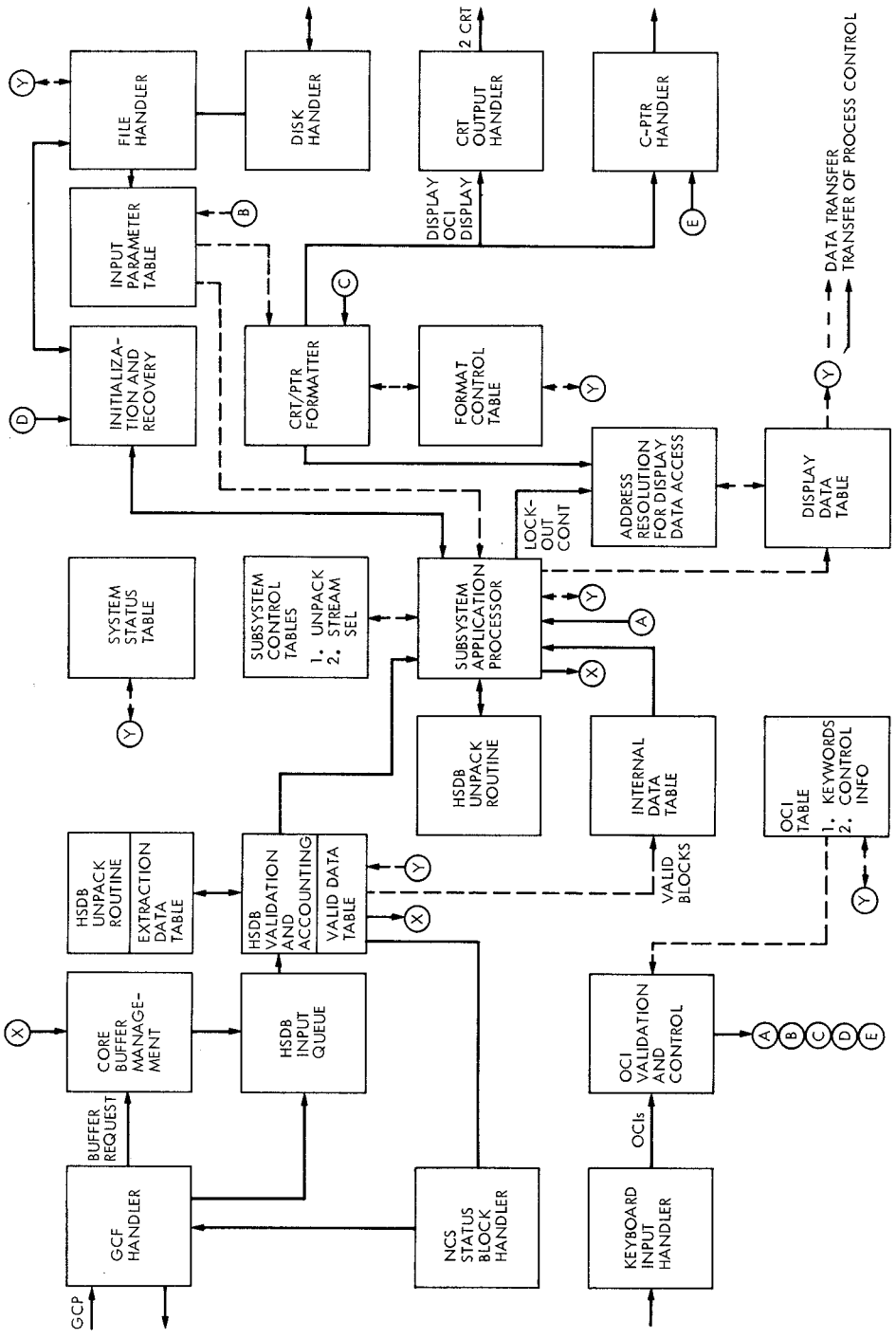

Fig. 7. Network Control System, Block II, real-time monitor software module diagram