Mark IIIA IBM Computer Configuration Expansion

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In order to meet Pioneer Project requirements, while continuing to support the Mariner Mars 1971 mission, it has been necessary to expand the SFOF computer configuration. This expansion has been implemented in the following areas: high-speed data input/output interface, display control and switching, subchannel extension and user device switching, and magnetic tape drives. Expansion was accomplished with minimum impact on operating system design.

I. Introduction

The original Mark IIIA configuration (see Ref. 1) was developed to meet the requirements of the *Mariner* Mars 1971 mission. Subsequently, the *Pioneer* Project requirements were solidified, and the degree of Central Processing System (CPS) expansion necessary to meet those requirements was determined.

In order to maintain programming compatibility and minimize schedule impacts, additions were restricted to existing type equipment. The only departure from this constraint involved a Remote Information Center (RIC), which was supplied by the *Pioneer* Project and located at the Ames Research Center.

Even though the *Pioneer* Mission Support Area is located in a building adjacent to the Space Flight Operations Facility (SFOF), standard IBM devices and channel interfaces are maintained. Fully redundant channel routing combined with remote device switching control is also maintained as in the original configuration.

The configuration, including the present expansion, represents a near maximum of input/output (I/O) devices and communications interfaces that can be effectively supported by a single Central Processing Unit (see Fig. 1). Future expansion requirements will probably require a significant change in the architecture of the Central Processing System.

II. High-Speed Data I/O Interface Expansion

The first complement of equipment consisted of six high-speed data (HSD) synchronizers for input and six HSD converters for output. While all six synchronizers could input data to both 360/75s simultaneously, only four of the six converters could output data from a 360/75. This constraint met loading requirements and reflected minimum implementation costs; however, it complicated operational assignment procedures and address designation.

The expansion design eliminated these problems along with providing the added capability. The total high-speed data input/output interface now consists of eight HSD

synchronizers, eight HSD converters, eight full-duplex HSD communication lines and two 8×8 switch matrix assemblies for independent selection of input and output lines.

The present rate of high-speed data is 4.8 kilobits per second. Studies are being conducted with the intent to increase the rate to 7.2 or 9.6 kilobits per second. The present HSD interface equipment is capable of either of the proposed new rates with minor timing adjustments.

III. Display Control and Switch Expansion

Before expansion, two IBM 2848 Display Controllers supported a total of 28 IBM 2260 Display Stations. Twenty-four of the Display Stations were individually switchable between the two 360/75 computers while two were permanently connected to each 360/75.

The addition of six more IBM 2260 Display Stations necessitated the addition of another IBM 2848 Display Control and expansion of the CRT Switch Unit. As designed, the line driving capability of the Display Control is capable of operating 2260 Display Stations at a cable distance of 609 m (2000 ft), which is well within the 365-m (1200-ft) requirement of the *Pioneer* Mission Support Area.

The third 2848 Display Control occupies the remaining position on the 360/75 multiplexer channel. Any additional expansion requirements would necessitate significant loading analysis and more channel capability.

IV. Channel Extender and User Device Switching Expansion

Support of the *Mariner* Mars 1971 mission required 24 User Devices and associated subchannels and switching units. These were distributed between Deep Space Network (DSN) and *Mariner* Mars 1971 user areas in the SFOF.

Eight additional devices required for *Pioneer* Mission Support Areas necessitated another subchannel, a subchannel extender to accommodate the 365-m (1200-ft) cable length and a switching unit to enable connection to either 360/75 computer. This addition utilized the remaining selector subchannel position on the 360/75. Further expansion of this type equipment will require another main channel on the 360/75 and also a thorough loading analysis.

V. Magnetic Tape Drive Expansion

Throughout development and early *Mariner* Mars 1971 mission support, the four 9-track and four 7-track magnetic tape drives were sufficient to handle processing input/output. The phaseover to *Mariner* Mars 1971 Mars Orbital Operation and the increased loading of the *Pioneer* Project development demonstrated a requirement for additional magnetic tape drives.

Subsequent analysis of interface and data exchange requirements yielded additional need for 9-track tape drives only. Two were installed on each 360/75, making a total of six 9-track and four 7-track drives for each 360/75.

VI. Conclusion

Additional user input/output devices and communications interfaces were added to the 360/75 with minimum impact on operating system design and schedule constraints. Due to the extreme loading of the system with the additional equipment and processing load, further expansion will require some degree of off-loading. The probable technique would involve the implementation of an input/output processor with the added capability of message buffering.

Reference

1. Stiver, R. A., "Mark IIIA IBM 360/75 Computer Configuration," in *The Deep Space Network*, Space Programs Summary 37-66, Vol. II, pp. 71–75. Jet Propulsion Laboratory, Pasadena, Calif., Nov. 30, 1970.

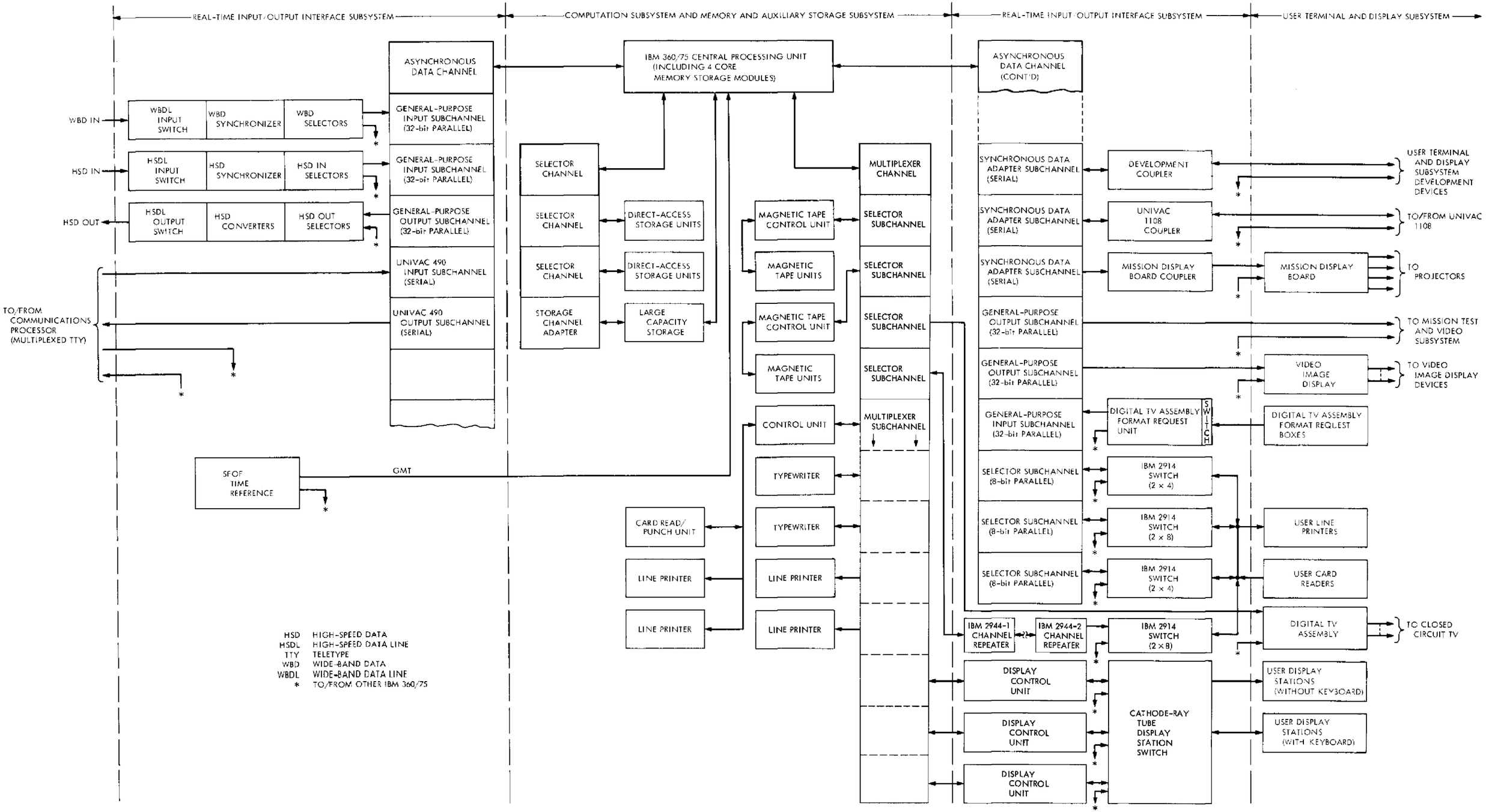

Fig. 1. Mark IIIA IBM 360/75 computer configuration