SFOF Mark IIIA User Terminal and Display Subsystem Design

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The user terminal and display subsystem (UTD) provides various users with the means to communicate with the Central Processing System in the SFOF. Prints, plots, alphanumeric, and graphic displays are presented on various peripheral devices and on digital television. This article discusses the requirements, design considerations, and implementation of the UTD.

I. Introduction

The user terminal and display subsystem (UTD) is one of eleven subsystems comprising the Space Flight Operations Facility (SFOF) Mark IIIA. Functions of all the SFOF subsystems were briefly described in Ref. 1. This article will describe in more detail the user terminal and display subsystem.

UTD provides the DSN and the flight projects with the tools to use the Central Processing System (CPS). See Ref. 2. The UTD is comprised of a variety of input/output (I/O) devices which, individually and collectively, provide the users with large amounts of data in easily digested form and at rates which are compatible with real-time decision making. The devices which provide these capabilities are partitioned into assemblies and subassemblies. This partitioning resulted from a design process based on many considerations. The prime consideration was user requirements.

II. Functional Requirements

For the support of spaceflight operations, each succeeding project requires more data from the spacecraft. The DSN in providing real-time support, also needs more data from its various facilities. This support ranges from sending commands in real-time, to the immediate viewing of spacecraft responses, to the recording of data for scientific analysis.

Functionally, the requirements for displaying information to the users have not really changed. However, the

amount of information which must be displayed has increased greatly. Also, the speed with which operations personnel must react has gone up in proportion to increasing spacecraft capabilities. In order to speed up reaction time, simpler means of communicating with various elements of the DSN and the spacecraft had to be devised. In achieving the increased capabilities to handle larger volumes of information, at faster rates, and in simpler formats, new user devices were required. Likewise, interfaces with other elements of the upgraded DSN had to be designed. Concomitant with the above considerations were reliability, maintainability, and cost of the new subsystem.

III. Technical Considerations

Throughout several years of spaceflight operations, JPL has gained experience which facilitates the design of a user terminal and display subsystem that optimizes the man-machine interface. This design has taken place in an evolutionary manner because of the necessity for continuing flight operations during upgrades of the SFOF. Teletype printers and mechanical plotters have been gradually replaced by more modern devices. However, this replacement, while welcomed by most users, has required changes in the operational philosophy of those users. People who have successfully used certain sets of devices for past missions tend to favor those devices for future operations. Yet, when consideration is given to greatly increased volumes of data, higher transmission and processing rates, and to the increased efficiency of modern computer peripherals, then the operators welcome the improved UTD capabilities.

In arriving at a final subsystem design, consideration was given to the creation of a universal user complex that could support all activities in the SFOF under a multimission environment. However, due to constraints of time and money, some compromises had to be made. With these constraints and with the decision to use the IBM 360/75 computer in the Central Processing System (Ref. 2) it became apparent that subsystem development had to proceed largely with off-the-shelf hardware. Furthermore, peripherals had to be selected such that they would be compatible with the JPL Real-Time Operating System (JPLOS) which constitutes the basic software used by all the SFOF systems and the flight projects. The selected devices were the IBM 2260 display station, the IBM 1443 line printer, and the IBM 2501 card reader. A user terminal switch assembly was designed for switching these peripheral devices between the CPS computers (Ref. 3).

Considerably less constraint was encountered in designing a means for data presentation. Large data volume, real-time decision making, and the multiplicity of users dictated a design which affords a visual display that simultaneously or separately presents many data formats in minimum time and in the most usable form. Although mechanical plotters have been removed, both strip plots and X-Y coordinate plots are required. It was determined that the foregoing considerations dictated the design of a multichannel digital television assembly (DTV) as part of the UTD subsystem. The DTV interfaces with the television assembly provided by the Ground Communications Facility which permits distribution of alphanumeric and graphic data for real-time usage throughout the SFOF. Reference 4 contains a description of the DTV.

IV. SFOF Mark IIIA UT&D Design

The above considerations resulted in a UTD design. The overall concept of the UTD and its assemblies are shown in Fig. 1. As mentioned earlier, the universal user complex could not be fully implemented, so the traditional user station concept was employed. Under this concept, the complement of equipment in each operating area was negotiated with the assigned users within the constraint of available resources.

Each area has been configured with some combination of user devices. The usage rationale for the devices is as follows:

DTV Display. Real-time data for mission operations will be displayed here. Immediate access to the data in an easily-used format will be provided. Both alphanumeric and graphics data can be displayed. Data needing immediate attention could be displayed with the background reversed. Wide distribution of data is possible through the TV assembly. For user versatility, a single monitor can access multiple channels.

IBM 1443 Line Printer. Data required in near-real time can be printed in a format convenient for usage in an operational area in a quick and efficient way. Administrative messages, such as processing status, alarms, and summaries, can be printed in multiple copies.

IBM 2501 Card Reader. Operational step initialization, parameter changes, special prearranged controls, prearranged device assignment changes and many other multiple input tasks that need near-real-time loading into the mission support computer.

IBM 2260 Display Station. The CRT display is used to display central processing unit and program status. The display is also used with the keyboard entry as an interactive terminal. The entry messages are composed. The computer reply will be displayed.

IBM 2260 Keyboard Entry Device. Operational control, command entry, program request, device assignment and format selection are available via this keyboard.

DTV Format Request Box. In cases where a user has cognizance over a number of DTV formats to be displayed on a few monitors and needs rapid changes, this box would be used.

DTV Hard Copy Printer. Although the DTV display is for real-time usage and therefore volatile, there will be occasions when a record would be needed for use in a time frame not suitable for off-line output. A hard copy of a display can be made for this purpose.

Teletype Printers. Some low-rate data, such as alarms and suppressed data, are provided on this type of printer. Until experience is gained on the other devices, these units will remain in service.

V. Conclusion

The SFOF Mark IIIA UTD Subsystem has been designed, and implementation is progressing. The *Mariner* Mars '71 flights and the *Pioneer F* launch will be supported from user areas located in the SFOF and the System Development Laboratory (SDL) respectively. Although located remotely from the SFOF, user areas in the SDL will be configured similarly to those in the SFOF.

References

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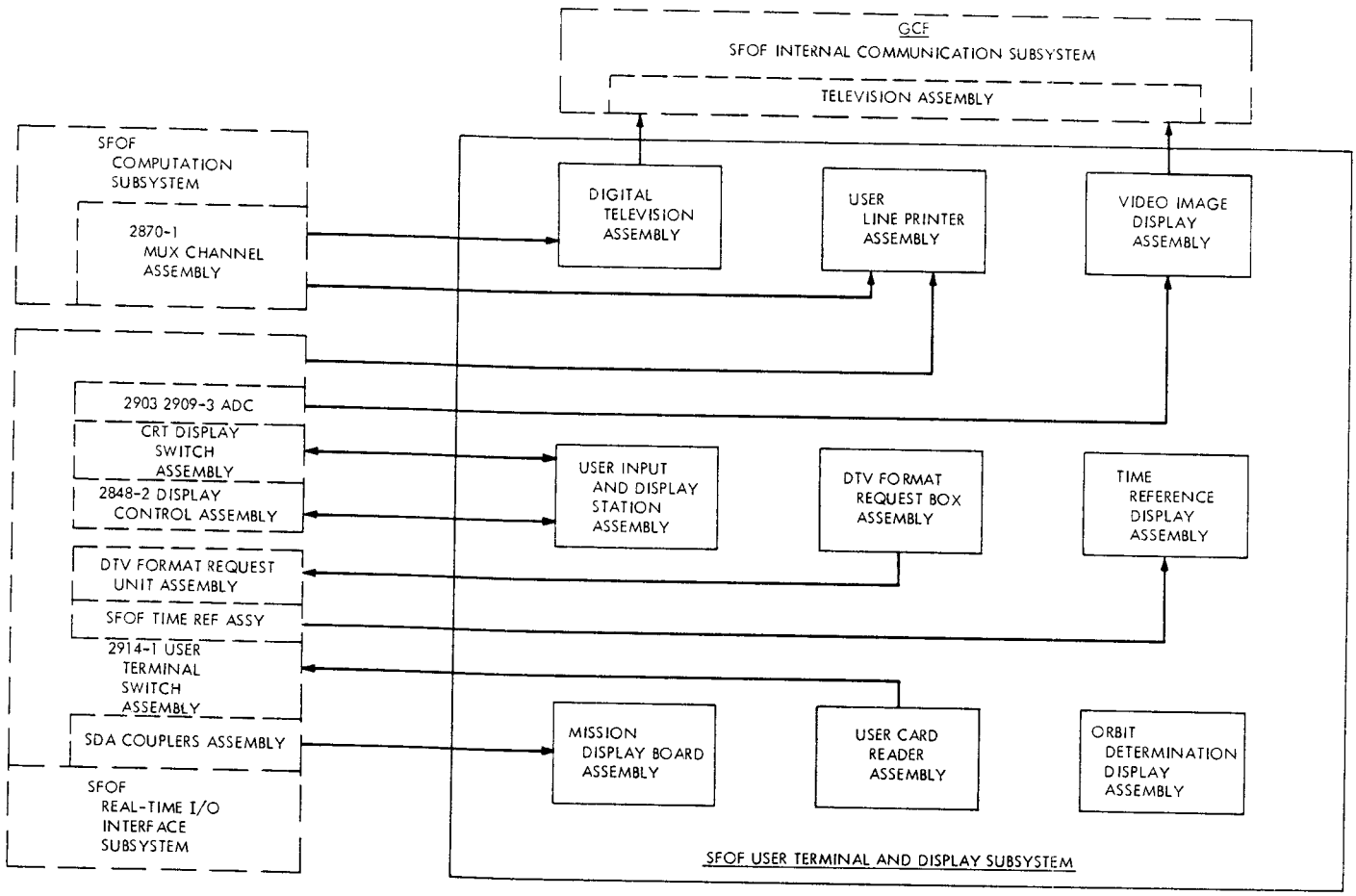

Fig. 1. User terminal and display subsystem assemblies and interfaces