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Author

Osborne, Carol.

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OPERATIONS ON-LINE TO A LARGE COMPUTER

Carol Osborne

28 October 1968

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Lawrence Radiation Laboratory
University of California
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INTRODUCTION.

The TRIST multiprogramming system was designed to coordinate computer use between the real-time Flying Spot Digitizer (FSD) programs and other data analysis programs. It has been in production since February 1965 and has made it possible to use the available computer time during FSD runs for other programs. This time amounts to approximately sixty percent of the time when the FSD is running so the system paid for its development in the first six weeks of use. Recently the analysis level programs have been put into production for pattern recognition and additions have been made to the system to allow a tandem FSD. I would like to briefly describe the system and then give an example of the time spent in the various levels.

SPECIAL FEATURES.

TRIST has several special purpose features which differentiate it from other operating systems. It allows the real-time FSD program absolute priority; it allows the second level priority programs to be cycled on successive batches of data; and it allows a general purpose third level of programs among which the priorities can be changed. A special feature of memory protect allows the use of one set of system subroutines by all levels and an interval timer allows both operator and program interrupts. The system uses a relatively small amount of storage (about 10700 words) and has a small overhead (two to three percent.)

The machine configuration used is seen in Figure 1. The computer is an LRL owned 7094 II with two, 32768 word, memories; multiprogramming features; and six data channels. Three of the channels are used for sixteen tapes, a printer, punch, card reader, and CRT; one channel is used by a disc file; one is used by an interval timer; and one is used for the direct data connection to the FSD.

A-LEVEL.

The highest priority ("A-level") is assigned to the real-time FSD program which is stored in one of the two memories. Data flow from the FSD is initiated by the real-time program and the central processing unit (CPU) is then free for other use. When a data storage block is filled, a trap to the CPU initiates real-time processing. The system services the trap within 500 microseconds to prevent loss of FSD data and allows the priority program to have continuous control for as long as necessary.

B-LEVEL.

The second priority level ("B-level") is assigned to a stack of as many as twelve analysis programs which batch process events just after their measurement by the FSD program. These programs are called in sequence during the time the CPU is free from A-level operation and cycled through on successive batches of data. Data pass from one program to the next via the disc file which is used as intermediate storage. The system maintains communication links for the different levels and protects the levels of disc storage.

C-LEVEL.

The third priority level ("C-level") is assigned to background data processing programs which can be anything from debug to the processing of data from a previous FSD run. This level operates whenever the CPU is free from the A and B levels. The sequence of programs in this level can be changed at any time and new programs can be added.

SYSTEM CONTROL.

The A-level program resides in one of the two memories at all times during a run while the B and C-level programs are flipped in and out of the second memory from the disc. TRIST resides in parts of both memories and uses some scratch area on the disc.

Figure 2 shows the interrupt and control features of the system. Four methods of interrupt are used: two data channel traps, one from the FSD and one from an interval timer; a memory protect trap when a protected area of memory has been referenced; and an operator interrupt which can be used to change priorities, add C-level programs, interrupt processing, initiate restarts, and so on. The interval timer causes periodic interrupts during which the system handles operator action requests, program requests for operator action, program stops and loops.

The memory protect feature protects the system, but is also used to allow multiple use of all system subroutines. All subroutine calls cause a memory protect trap and therefore go through the memory protect routine which will

allow prior use of a subroutine, if any, to complete before allowing the current call to the subroutine. Therefore all system subroutines are available to any of the levels and do not have to be an actual part of each program. Time accounting is done for each program and for the system itself.

Figure 3 shows an example of the way in which the levels work. The system reads the FSD program and starts it. From that time on, the FSD program has the priority and everything else is done when it does not need the CPU. All B-level programs are read in and stored and a C-level program may be read and started while the first batch of data is accumulating. If there are no C-level programs, the system goes into a pause loop. As soon as a batch is ready, the C-level is interrupted and the B-level programs are started while A-level accumulates the next batch. As each B-level program finishes, it is saved on the disc for the next cycle. After all B-levels have been completed, the interrupted C-level is recalled. When the next batch of data is ready from A-level, the B-level programs are called in again and so on. When the B-level programs are running with diagnostics (therefore running slowly), A-level may be ready for the third batch before B-level has finished the first batch. Since A-level writes the third batch over the first batch area, the system inhibits the A-level program until B-level catches up.

TIMING.

An actual time scale can not be shown on Figure 3 due to the limited space. A batch of data, currently set as fifteen triads, requires about ten minutes for measurement. Approximately twelve seconds of the ten minutes, or two percent of the time, are used by the system. (Four seconds are needed for each core to disc exchange of programs and three programs are exchanged for each batch). Exchange of control when a trap occurs requires about .1 percent of the time and servicing the interval timer interrupt requires .03 percent.

In DAPR processing, the FSD takes approximately forty seconds to measure a triad (three sweeps each of three views). About twelve seconds of this time are spent in the FSD program (A-level) and three seconds in the analysis programs (B-level) leaving twenty-five seconds of each forty for background programs. With the tandem FSD, approximately thirty seconds of the forty will be used by the A and B-levels.

CONCLUSION.

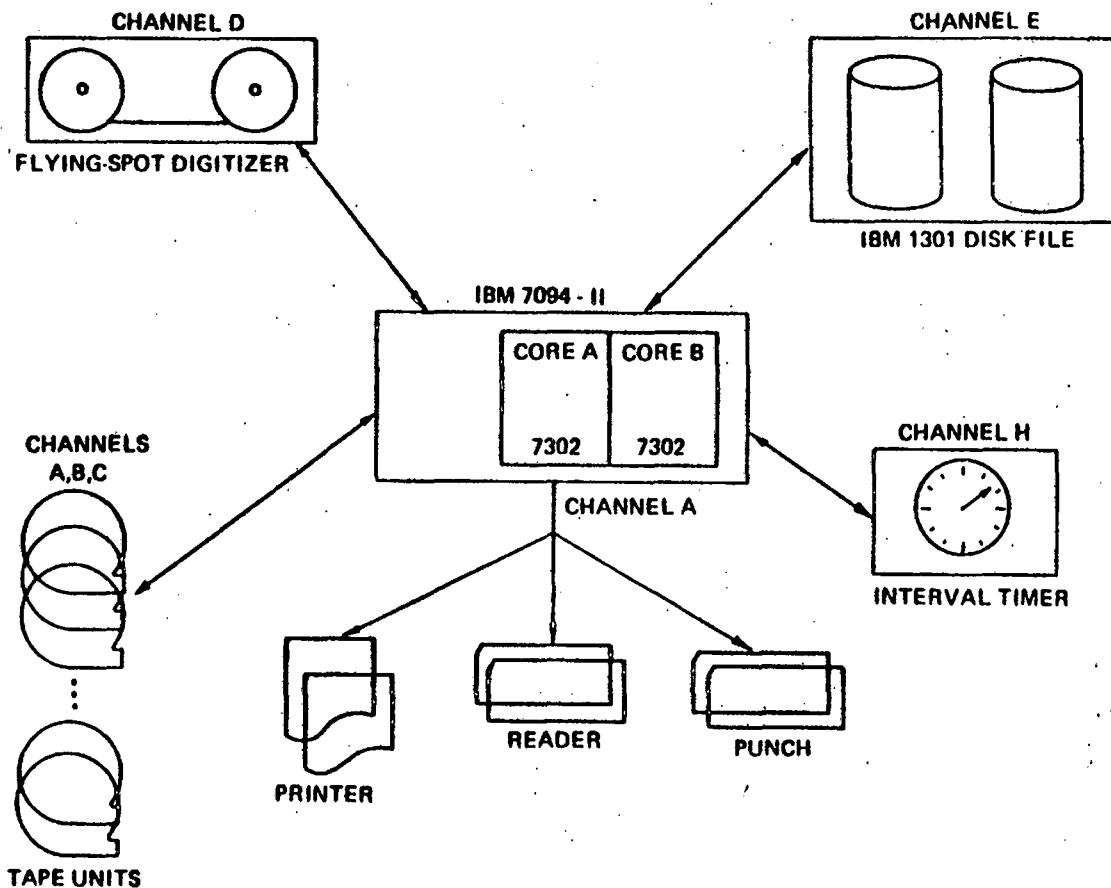
The system has achieved its purpose of making the computer time available during FSD runs usable for other programs and has therefore also made it economical to use a large computer with the FSD. Currently, additions are being put into the system to allow acceptance of data from the tandem FSD which is being built.

FIGURE CAPTIONS.

- Figure 1. Machine configuration.
- Figure 2. Interrupt and control features.
- Figure 3. Example of computer use under TRIST.

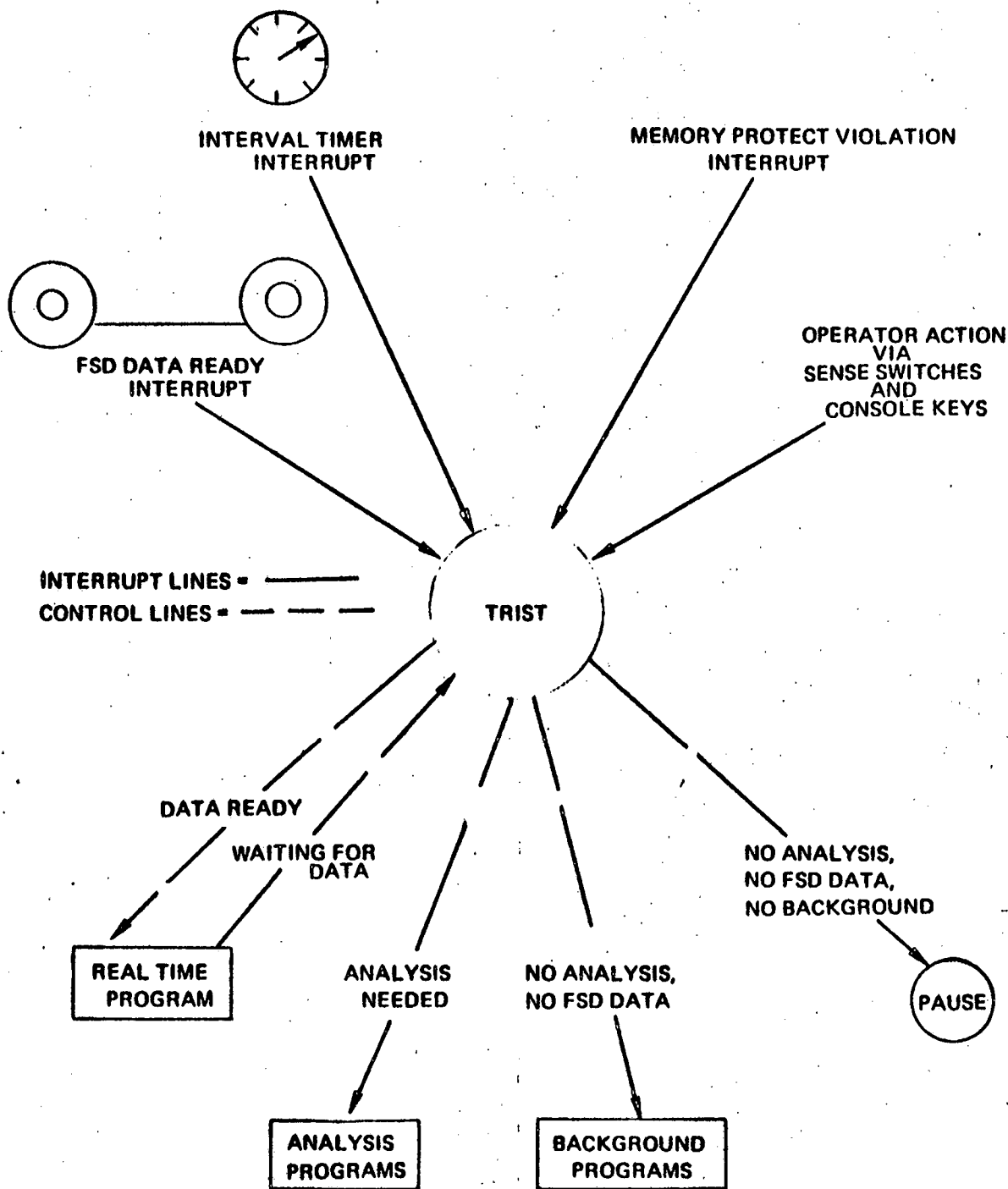
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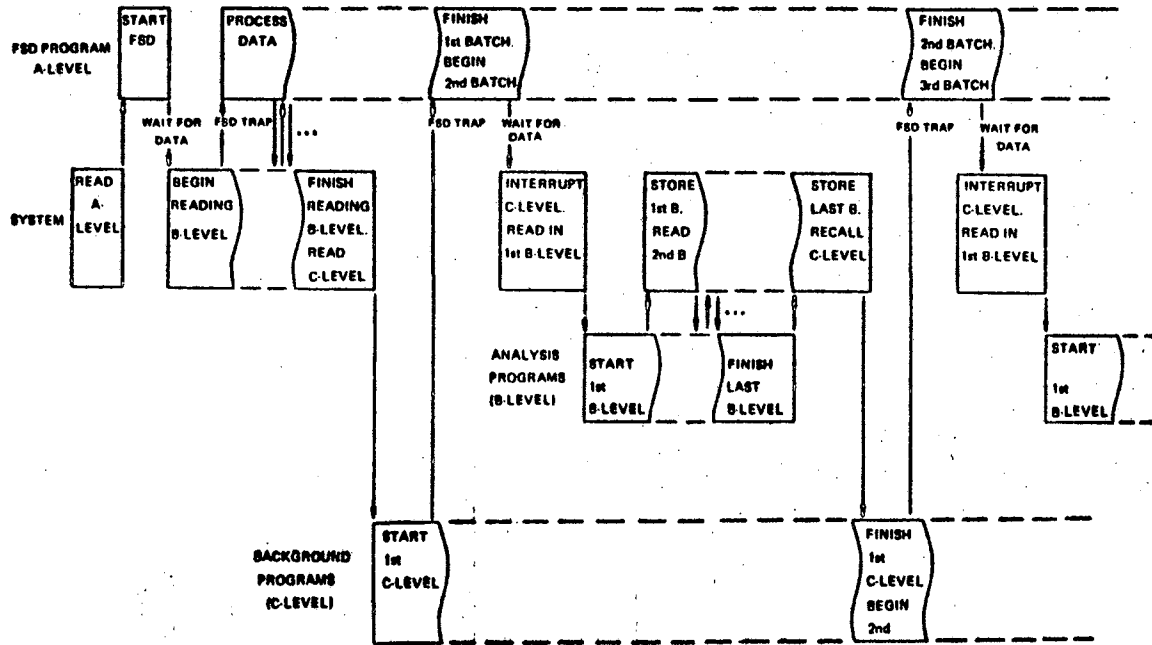
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Fig. 1



XBL 6810-6038

Fig. 2



NEL 6810-6039

Fig. 3

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