May 1, 1959

MEMO TO: Mr. D. W. Holmes

SUBJECT: SWIFT Tape Systems

REFERENCE: Your memo 4/8/59 to Dr. H. G. Kolsky

1. The SWIFT objective of developing a modular tape system seems very desirable. Our planning for 7030 Systems assumes the following components which we may call a 7030-SWIFT System.

1	Read Control Unit
1	Write Control Unit
4	Motion Control Units
8-32	Tape Transports

Two of these "systems" can be attached to the 7030 Exchange in an eight channel block. Thus, we would provide for two Reads or Writes occurring simultaneously or any combination with a maximum of three Transports transmitting or receiving data. These systems would provide maximal data flow through the Exchange.

2. We would like to attach the Motion Control Unit directly to an Exchange Channel. This may require some level of additions to the MUC in the sense of an adapter. However, this will result in providing an effective address for the Motion Control Unit. The physical and logical arrangement of the SWIFT system indicates that pre-selection and interlocking of one Tape Transport attached to a Motion Control Unit should be possible. The requirement for such an operation is due to the "bottleneck" effect of the Motion Control Unit associated with a string of Tape Transports. The ability to interlock a Transport and Motion Control for subsequent operations is basic to 7030 usage.

3. The Exchange is capable of determining whether a channel is busy in approximately 1 micro-second. It does this by examination of bits in the Control Word stored in its memory. These bits are set, for the Channel, upon successful completion of a "select" operation. However, as a consequence of the "instruction acceptance" determined within the Exchange and a single Read-Write Control for four "Channels", provision must be made for the Motion Control Unit to retain, or "stack", the Read or Write request until it can be acted upon. Such "stacking" is predicated on the fact that the Motion Control Unit and the "selected" Transport are "Not Busy" when a Read or Write is given.

4. Four classes of operation are possible:

   (A) Reading and Writing
   (B) Dependent Control Operations
   (C) Independent Control Operations
   (D) Miscellaneous

(A) Reading and Writing:

These operations require interlocking a Read or Write Control Unit, a Motion Control and a 250 KC Tape Transport. These system components would be used in the following way.

(a) Upon receipt of a Read or Write instruction, the Exchange will determine whether the "Channel" or Motion Control Unit is busy. If the "Channel" is busy the instruction is rejected. If the "Channel" is not busy the instruction is forwarded to the Motion Control Unit, where it can be "stacked" if the Read or Write Control Unit is busy with another "Channel". Any other instruction requests to this "Channel" will be rejected on a "busy" basis until the "stacked" instruction is completed.

(b) When the Motion Control Unit accepts a Read or Write instruction, it will attempt to interlock with the Read or Write Control Unit. If the interlock cannot be made, because the required unit is already busy, the Read or Write instruction will be retained until it can be acted upon. Since this implies all for Motion Controls can be requesting Reading or Writing attention a positional priority is assumed in the Read and Write Control Unit. Each MUC can set a bit in a 4 bit trigger set. Scanning of these triggers sequentially would permit Read or Write Control interlocking with the proper Motion Control Unit.

(c) Since the data words required for Writing or developed in Reading utilize core storage locations associated with the "Channel" or Motion Control Unit address, the Exchange must provide for switching of data lines between the proper data words assigned to the block of Channel addresses assigned to the SWIFT system. The switching of data lines would be interlocked with the connection of the Read or Write Control Unit and the Motion Control Unit. Thus, data can be supplied for any "Channel" from the data words corresponding to (or associated with) a Motion Control Unit.

(d) It is necessary, for the transfer of status information, to provide direct connections between the Exchange and the Motion Control Unit. It would seem simple to expand this connection to include all control information through this linkage. Such logic is consistent with the notion of distinct strings of transports attached to specified Motion Control Units. This connection would include ability to handle the data service request signals.

(B) Dependent Control Operations:

This class of operations includes all control operations using both a Motion Control Unit and a Tape Transport, but not a Read or Write Control Unit. From SWIFT Memo #27 these include:

Write End of File Mark
Space Records (in either direction)
Space Files (in either direction)
Select for Test

Spacing of N records is possible with the Exchange and need not be included in the SWIFT system. Search for a particular file can be accomplished readily with 7030 systems and need not be built into SWIFT. A more complete discussion of how this is accomplished is being prepared in a more detailed analysis of the SWIFT - 7030 System.

(a) The Exchange will accept or reject the instruction on the basis of its knowledge of the busy-not busy status of the Motion Control Unit.

(b) Upon acceptance of the instruction the "Channel" will become busy and the instruction executed. Note that one further instruction should be included here. This should be:

"Select for Use"

The "Select for Use" would couple the addressed Transport and the MUC for subsequent control, read or write instructions. Once coupled the "Channel" busy status refers to the combined MUC-Transport. This selection status is required prior to all types of instructions.

(c) When the operations of this class are completed and "End of Operation" indication will be supplied to the "Channel" control lines.

(C) Independent Control Operations:

This class of operations requires two phases of action. First they require brief coupled action between the MUC and Transport for initializing the operation. Secondly they proceed to completion through independent action at the Transport. Such operations include:

Rewind
Load Cartridge
Unload Cartridge

and combinations of these.

(a) As with all instructions the Exchange will accept or reject the instruction on the basis of its knowledge of the busy-not busy status. Note that the Control Word information relates to the Motion Control Unit and the pre-selected tape transport.

(b) Upon acceptance of the instruction the "Channel" will become busy and the instruction executed. When the combined MUC-Transport action is completed and the Transport becomes "free running" the Channel will register End of Operation.

(c) Once the Transport is free running the Channel will give a "Not Ready" indication unless another Transport is connected to the Motion Control Unit. In any case, though the Transport will supply a "Unit Signal" when it completes the "free running" operation and if it returns to a Ready status.

(D) Miscellaneous:

The ability to retain "status" bits in the Motion Control Unit until the unit is free from current activity is important. Upon completion of current activity, the accumulation of status indication would be sent to the control word.

5. A further planning meeting in May seems a very desirable thing. From my study of the SWIFT system it would appear that all using systems would have some basic points to iron out. It is very important that full understanding between user systems be achieved with respect to tape format and positioning of bits. Inter-system compatibility is a major consideration. This item should certainly be included in any general planning discussion. The intention to write 16 informations bits on SWIFT should also be made clear.

6. Consideration of the four lower speed tape options mentioned in your memo leads to the conclusion that a 15 KC SWIFT @ $300 per month would be the best buy.

Note: Reading a card @ 800 cards per minute takes .075 sec. or 75 ms.
Printing a line @ 600 lines per minute takes .100 sec. or 100 ms.
Punching a card @ 250 cards per minute takes .240 sec. or 240 ms.

Tape to Memory transfer rates are:
15 KC SWIFT = 133 us per pair of characters
60 KC SWIFT = 33 us per pair of characters
With a 15 KC SWIFT we have:

(a) Load or unload 80 characters from cards
(.133) 40 + 3.0 = 8.32 ms.

(b) Transfer 132 characters for printing.
(.133) 66 + 3.0 = 11.78 ms.

With 60 KC $WIFT we have:

(a) Load or Unload 80 characters for cards
(.033) 40 + 3.0 = 4.33 ms.

(b) 132 characters for printing
(.033) 66 + 3.0 = 5.18 ms.

If these times are "overlapped" the 15 KC SWIFT is sufficient. If they are not overlapped, the transfer rate of the 15 KC SWIFT is still sufficient for interval between cards and the 20 ms. spacing time of the printer. Thus, the 15 KC tape is feasible.

In general the preparation of a tape to keep all three devices busy is extremely difficult and probably undesirable from a programming point of view. Therefore, since the card or printing device ultimately determines the tape speed a 15 KC Drive at $300 is most useful. All others would actually operate at the same "through-put" rate as greater cost.

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