

STRETCH  
LINK

August 16, 1956

Intra-Communication of the LINK System

A method of communication must be established within the units comprising the LINK System. This memo presents a tentative outline of the lines of communication considered necessary to properly control, police, or analyze the functioning of the LINK System through the LINK Computer. Arbitrarily defined is a Tote board or an array of selectors and indicators which is in effect, a clearinghouse for information.

The areas of communication herein considered are those directly related to the LINK Computer and consist of: LINK Computer to LINK Exchange, Input-Output units to Tote board, LINK Exchange to Tote board, LINK Computer to Tote board. Areas not defined in this memo are: Input-Output Units to LINK Exchange, and LINK Computer and Tote board relationships with not yet defined High Speed, or Low Speed (keyboard) input output units, and LINK Computer to Main Memory communications.

1.0 LINK Computer and LINK Exchange communication.

The minimum number of lines necessary for effective control are listed below.

1.1 Lines controlled by the LINK Computer - information being sent to the LINK Exchange unit.

- a. 1 line Select for Read. A
- b. 1 line Select for Write. B
- c. 1 line Select for Control. C
- d. 20 lines Address of Control Word. A, B
- e. 8 lines Address of I/O unit to be used. A, B, C
- f. 4 lines Control function information C

1.2 Lines controlled by the LINK Exchange unit, information being sent to the LINK Computer.

- a. 1 line Response to end Execution of Assigning instruction. A B C

- 1.3 Total number of line communicating between the LINK Exchange and LINK Computer are 36 (sum of 1.1 and 1.2).
- 1.4 Operation of the Select instruction in the LINK Computer.

It is contemplated that the select instruction in the LINK Computer will be unique in operation. A typical select instruction might contain the following information:

Select for Read	10 bits op code
Address of I/O Unit	8 bits
Address of Control Word	20 bits
Conditional Transfer Address	20 bits
Code	6 bits

Before any communication is established with the LINK Exchange, reference is made to the Tote Board to determine that:

1. The unit to be used is not in an End of File condition.
2. The unit to be used is available and Ready to be used.
3. The LINK Exchange unit is Ready for assignment for a Read operation.

If the above conditions are satisfied then the Select for Read, Address of Control Word, and Address of I/O Unit are communicated to the LINK Exchange. When the LINK Exchange has accepted the information, a Response to end Select execution is returned to the LINK Computer, which then proceeds to execute its next instruction. Provision is made that if for one of the reasons mentioned, the Exchange unit is unassignable, the computer can be made to:

- a. Skip one instruction and continue with its program.
- b. Transfer program control as designated by the conditional transfer address.
- c. Do b as indexed by the code in the instruction.
- d. Stop the computer from continuing.
- e. Anything not herein listed that can be demonstrated to be practical and beneficial.

- 2.0 Input-Output unit communication to Tote board.

The Tote board is an assembly of selectors and indicators, controlled by represented devices, interrogable by the LINK Computer (other units may possibly interrogate the conditions recorded) and reset by, the LINK Computer, LINK Exchange, or I/O units as deemed logical and proper for the specific indication. Figure 1 contains a Tote board physical layout and a chart indicating a logical organization from which the overall concept of the Selector, Indicator and control system should be made clear.

- 2.1 Lines controlled by the Input Output units represent information being sent to the Tote board to centralize the access to varying machine conditions. Each I/O will have its own lines, representing its own particular status, and will be responsible for initiating representative conditions. Removal of particular representative conditions can be controlled either by the I/O unit directly (as in the case of a Ready condition) or by the I/O unit under control of the LINK Computer (LINK Computer turns off End of File in I/O via control instruction, E. O. F. indication being off in I/O unit removes indication from Tote board.)
  - 2.2 Lines controlled by I/O units sending information to Tote board.
    - a. I/O Error
    - b. I/O End of File
    - c. I/O Not Ready
    - d. I/O In use
  - 2.3 Each I/O unit has its own communicating lines to the Tote board through the LINK Exchange unit. The organization of the I/O conditions on the Tote board reveals a potentially useful scheme for interrogation. The arrangement of columns and rows makes it possible to interrogate an entire column, an entire row, or any specific condition by properly assembling the address of an interrogation instruction.
- 3.0 LINK Exchange to Tote board communication lines.
- 3.1 There are certain conditions within the LINK Exchange that must be made available to the computer controlling the input output operations. Certain of these conditions can be defined at this point and are listed as tentative. Since the Tote board is the central information point, the LINK Exchange will provide lines conveying the following information to the Tote board:

- a. Exchange Ready for Rd. (M. S.)
- b. Exchange Ready for Wr. (M. S.)
- c. Exchange Ready for Ctrl. (M. S.)
- d. Exchange unassignable
- e. Exchange Ready Rd/Wr. (H. S.)
- f. Exchange Error

3.2 Not all of the exchange information lines have been completely defined. However, it is presently felt that the items listed suggest conditions that it would be beneficial to interrogate.

#### 4.0 LINK Computer to Tote board-communication lines.

The definition of the LINK Computer operation at this date has not solidified to a point where any realistic list of communication lines can be prepared. The list presented is one that should provoke thought and comment so that all arguments can be evaluated to result in the most effective and flexible communication and control system available.

4.1 In the case of multiple instruction counters in LINK Computer it is recommended that one of each of the following items be associated with each instruction counter.

- a. Sign condition (plus or minus as set by last arithmetic instruction controlled by its associated instruction counter).
- b. Zero condition.
- c. Overflow.
- d. Underflow.
- e. High, low and equal.
- f. Error (divide by zero attempt - LINK logic error, etc?)

4.2 To provide for attaching or associating control data with specific input-output units, a row (or more than one row) of Logic control indicators be added to the I/O unit vs Function matrix on the Tote board. The Logic control indicators will not be turned on according to predefined machine conditions as per item 4.1, but will be dependent upon execution of a specific control instruction, executed only when programmed to do so.

4.3 Comparable to item 4.2, a system of non-associated indicators should be provided (perhaps in matrix form) so that programs identifying conditions, may store data to be later used in modifying another program. These indicators may or may not have the ability to be controlled externally - e. g. by the machine operator.

- 5.0 The areas of communication not discussed are listed with the present reasons for no attempt at definition.
- 5.1 Input-Output (H. S. ) communications with LINK Exchang primarily not discussed because too little is presently known about the characteristics of the High Speed I/O units, secondly this is an area of prime concern to the LINK Exchange and I/O sections rather than the LINK Computer.
- 5.2 LINK Computer communications relative to H. S. I/O units. Too little is known concerning the High Speed I/O units, and it may be sufficient to extend the controls already defined for the medium speed I/O units into this area.
- 5.3 Tote board communications with High Speed I/O units - same reasons as listed in 5.2.



WW:gmp

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# TOTE BOARD PHYSICAL ORGANIZATION

COLUMN ADDRESS	I/O #1	I/O #2	I/O #3	I/O #4	I/O #5	I/O #6	I/O #7	I/O #8	etc →
Row ADDRESS	0000	0001	0010	0011	0100	0101	0110	0111	1000
000--									
I/O ERROR	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	
I/O END OF FILE	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	
I/O NOT READY	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	
I/O IN-USE	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	
PROGRAM USE (LOGIC CTRL)	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	

⊗ - SYMBOL FOR INDICATOR

SELECTOR CONDITION	TURNED ON BY	TURNED OFF BY	INTERROGATED BY	
I/O ERROR	I/O UNIT	I/O THRU LINK	LINK COMP	*
I/O END OF FILE	"	"	"	*
I/O NOT READY	"	I/O	"	*
I/O IN USE	"	"	"	*
EXCH RDY READ (M5)	EXCH	EXCH	"	
EXCH RDY WRITE (M5)	"	"	"	
EXCH RDY CTRL (M5)	"	"	"	
EXCH UNASSIGNABLE	"	"	"	
EXCH RDY R/W (H.S.)	"	"	"	
EXCH ERROR	"	LINK	"	
PLUS COND	LINK	"	"	
ZERO COND	"	"	"	
OVERFLOW COND	"	"	"	
LOGIC CONTROL PROGRAM USE	"	"	"	

\* MULTIPLE INTERROGATION IS POSSIBLE

etc.

fig 1