Loose Communication Between Dissimilar CDC 6000 Systems

by

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Technical Report 73007   November, 1973

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Abstract

This paper describes a system, known as LINK, which provides inter-machine communication between like machines operating under significantly different operating systems. The methodology employed by LINK was selected from among several alternatives on the basis of effectiveness, complexity, and cost.

Introduction

Inter-machine communication is not a novel idea, as the ARPA network clearly demonstrates. This paper describes a system which is, therefore, novel only as regards its simplicity and effectiveness. Specifically we describe a system, known as LINK, which provides inter-machine communication between a CDC 6400 operating under the KRONOS[1] system and a CDC 6600 operating under a system known as MOMS.* The 6400 is devoted exclusively to time-sharing while the 6600 is engaged in local and remote entry batch processing. We shall refer to the former as the timesharing system (TSS) and the latter as the batch system (BS). Figure 1 depicts the configurations.

Owing to the limited resources of the TSS and the obligation to provide short response times, jobs requiring large tape or disk files and/or long computation times are forced to the BS. In addition, since a plethora of software packages and language processors is available on the BS, that are not so available on the TSS, an additional set of computations not included in the above

*Externally MOMS resembles the SCOPE series of systems.

category are also relegated to the BS. These conditions force a large segment of the user community to use both machines. The absence of inter-machine communication makes interleaved use of the facilities impossible and constitutes an inconvenience that cripples both systems. To alleviate (or at least mitigate) this inconvenience, the ability to pass data between the two machines is essential. LINK provides that capability.

Before outlining the features of LINK, we remark that the above deficiencies could have been alleviated in any of several ways. The alternatives considered are enumerated and briefly discussed below.

That is, the desired communication could be provided by:

1) Operating both machines under the TSS and providing TS on both machines. This was possible since the TSS has a batch processing sub-system.

2) Sharing a disk(s) device between the two machines and continuing to operate under dissimilar systems.

3) Providing channel to channel communication between the two machines. This is possible since the two machines are in adjoining rooms. Were they geographically separated, voice grade communication could be employed, as has been demonstrated.[2]

4) Providing other than channel to channel communication. Extended core storage[3] could serve, for example, as an exchange device.

The selection criteria dictated that the system be 1) low in cost to develop and maintain; 2) simple and modular in structure; 3) simple and yet powerful to use, and 4) simple to implement.

Mindful of the above possibilities and constraints the LINK strategy selected, uses ECS as an exchange device. Although the complete reasons for discarding strategies 1-3 will not be given, indications which contributed to the rejection of each can be given. A point by point summary is as follows.

1) Although changing systems is conceptually simple, the time and money necessary to effect the change are enormous. Furthermore, in an environment which supports both time-sharing and batch processing, batch service is necessarily of lower priority than TS service, and is thus of lower quality. This alternative was therefore rejected on the basis of economic and policy considerations.
2) Although the file structures for the two systems are logically equivalent, the disk recording schemes are not. Device sharing necessitates, therefore, a significant alteration in the recording policy of one of the systems. Of more importance is the fact that sharing necessitates system communications to effect the sharing. This combination of requirements makes the alternative unappealing.
3) The first option entails significant hardware acquisition costs, while the latter requires both initial and recurring costs.

In order to present a reasonable account of the LINK system a few of the salient features of each of the operating systems will be given.

TSS

1. Although designed and used for interactive computation, the system possesses a batch sub-system. The command language associated with that system is very much like that found on the BS.
2. Access to the system requires that the user be in possession of a valid account number (aa) and password (pw). These items also serve, then, to identify system users.
3. Two distinctive disk file structures exist and are known as direct and indirect. For files established as direct, disk space is allocated in large blocks and such files are in possession of write interlocks and can be made permanent. Files established as indirect are accessed by making a working copy of (access by value) the file. For such files, disk space is allocated in small blocks. Most files employed in interactive computing are of type indirect. Indirect files employed in interactive computing are of type indirect. Indirect files can also be made permanent. For both types passwords can be attached (fpw) to provide security.

<u>BS</u>

1. Batch jobs are identified by system assigned job names (jn.).
2. A valid account number (ac) is required to gain access to the system.
3. As each job is processed a chronologically ordered file, known as the DAYFILE (df) is accumulated which contains, among other things, a record of all command language statements obeyed as well as system generated messages.
4. For purposes of this discussion we can imagine four file types exist. They are

   I - input. Batch job decks.

   O - output. Has a disposition code (dc)

   P - permanent (p). To be retained.

   L - local. To be discarded when the command language statements of the associated job deck are exhausted.

   A handling code (dc) determines the file type and/or destination.
5. The remote batch entry stations are identified by two letter mnemonics known as site codes (cc).
6. On both systems files are identified by file names (fn).

<u>User Viewpoint</u>

Using ECS as an exchange device, LINK allows <u>files</u> to be transmitted between the two systems in either direction. The mechanism is not, however, completely symmetric, since symmetry would require the BS to respond to interactive requests. Evocation and control of LINK is contained in the three simple commands XMIT, STATUS and SEND. The first two represent TS commands and the last a command language statement for the BS. Figure 2 summarizes the flow of data and control information between the two systems.

With this brief summary the link commands can be given in their entirety. For transmission from the TSS to the BS the command

XMIT,fn,dc,aa,cc.

is used. For transmissions from the BS to the TSS the command

$SEND(fn_1=pfn_1,\ldots,fn_k=pfn_k,ac,pw,t)$

is used. To clarify the latter command, two comments are in order. First, the format implies that files transmitted from the BS to the TSS are placed in permanent file storage (disk files) under the account number and password specified. The parameter t specifies direct or indirect. Secondly we remark that XMIT and SEND only schedule the transfers, thus implying that the next control card or TS command is interrogated immediately and the job or user is not delayed while the actual transfer is made.

For transmissions initiated by XMIT, the terminal user is given as an immediate response the jn under which the file can be referred to and/or will be known as on the BS. Although following this response the terminal user is free of any further responsibility for the transfer, the status of the file in the BS can be made known by issuance of the command

STATUS,jn.

The response indicates the current status of the file transmitted. Typical responses might indicate that it is in the input queue, being processed as a job deck, being printed, etc., as appropriate, that is as determined by dc. Additional pertinent remarks are now summarized.

1. For all commands diagnostic messages are issued as necessary. For example, for all transfers user validation is checked on the destination system and messages issued if it is not authorized, i.e., the account number (aa or ac) and/or the password (pw) are not legal. Possession of a legal aa or ac and pw is, however, not sufficient to initiate a transfer. To avoid abuse of the facility, each account number must be authorized to use the link facility, and such authorization is kept as part of a "permissions" record associated with each TSS account number.

2. To ensure that a record of all BS activity resulting from an XMIT command is made available to the TS user, following completion of that activity on the BS the associated dayfile (df) is automatically transmitted to the TSS, and appended to a file named DAYFILE under the appropriate ac and pw. All other files are discarded upon job completion unless explicit disposition has been requested. Accounting information necessary to charging for the use of LINK is also recorded.

The above three commands, together with the usual batch utility programs are sufficient to provide a powerful and flexible tool. In the main the system is used to extend the scope and power of the TSS, although as should be apparent, it is not so limited.

As a simple example, consider sending a FORTRAN program from the TSS to the BS for execution, with the provision that the output be returned to the TSS for later listing on a terminal. Further suppose that the program is on file FP and on the TSS and written to record output on a file named RETOUT. The details of the example are not given. Entries of the form HH.MM.SS reflect the then current clock time.

On the TSS we type

```
BATCH,30000
RFL,30000
/CCR,INPUT,COM
?COM,CM43000.ac(job card)            control cards for BS
?RUN(S)        (compile)
?LGO.          (execute)
?SEND(RETOUT=LIST2,D)                (request that output be
?                                    returned)
/APPEND,COM,FP                       (combine files to single
                                                file)
/XMIT,COM,INPUT,ac                   (schedule transmission)
14.18.50.COM648L                     (BS jn response)
(remainder of session)
```

Upon completion the dayfile returned might read

```
14.20.01.COM648L
14.20.01.COM,CM43000.ac
14.20.02.RUN(S)                      (compile)
14.20.20.CTIME 000.750SEC            (message from compiler)
14.21.20.LGO.                        (loading and execution)
14.21.40.END PROG                    (end of execution)
14.21.41.SEND(RETOUT=*...*,D)        (aa, pw implied those of
                                                originator)
14.21.42.FILE SENT TO 6400 RETOUT    (indicates that the file
                                     has been scheduled for
                                                transfer)
```

Implementation Considerations

To be consonant with the criteria of simplicity, the implementation is highly centralized or modular. This strategy insures that a minimum number of extant system components are disturbed and thus eases other or future system development.

On the BS transfers are handled by a CPU-PPU package known as SUPIO. SUPIO is responsible for all spooling operations including transfers to and from the multi-stream concentrator embodied in a PDP-11. Implementation required the addition of a minor amount of CPU code and a single PPU overlay resident on ECS*. The allocation of additional buffer space in SUPIO was not necessary. Since SUPIO is active as long as the BS is operational the LINK facility is continuously available. Since the TSS is not in possession of unit record equipment, the TS side of the LINK software was not incorporated into the counterpart of SUPIO, although it exists. Furthermore to conserve memory space on the TSS, the LINK facility need not be continuously available. Instead the facility is activated by the operator command ENABLE XMIT which starts a PPU program named XMIT. It initializes handshaking with the BS and then keeps the communication path open by becoming periodically active and checking for the need to transfer files. Actual transfers are handled by a package known as ECSXFER which becomes attached to a control point at

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*ECS is used as a reservoir for systems overlays for both the BS and the TSS. A complete description of the methodology employed has been previously reported.[4] Figure three indicates the apportionments.

the direction of XMIT. It engages in the actual bi-directional, duplex transfer of files. Information related to the command STATUS does not require ECSXFER but is handled instead of XMIT and the PPU program responsible for terminal communication.

An assessment of the transfer rate is difficult, since it is dependent on the activity of both systems as well as the logical record structure of the transmitted file. The only potential bottleneck is the buffer used by SUPIO. To date SUPIO buffer utilization is about 15 per cent (by all SUPIO activity) so that considerable growth is possible.

At present, nearly 300 files are transmitted daily and in all cases, an imprecise assessment of the transfer rate shows it to be quite satisfactory.

Discussion

We have presented this short report in that the LINK system while simple, is powerful and has been shown (by use) to constitute a satisfactory coupling of the two machine configurations.

Although the ECS strategy was chosen, in part, on economic grounds (in that ECS was a part of the BS configuration and thus available for use) we feel that it has other merits, in that it taxes those resources best able to absorb the strain. In particular it relieves the heavily used PPU's of the transfer responsibility and instead places the burden on the CPU, a resource which is to date under utilized. It represents, furthermore, an approach quite different than the one reported by Benson, et. al.[5]

Acknowledgement

We should like to acknowledge the services of John Eikum of the University Computer Center for his assistance in the implementation of the LINK system.

References

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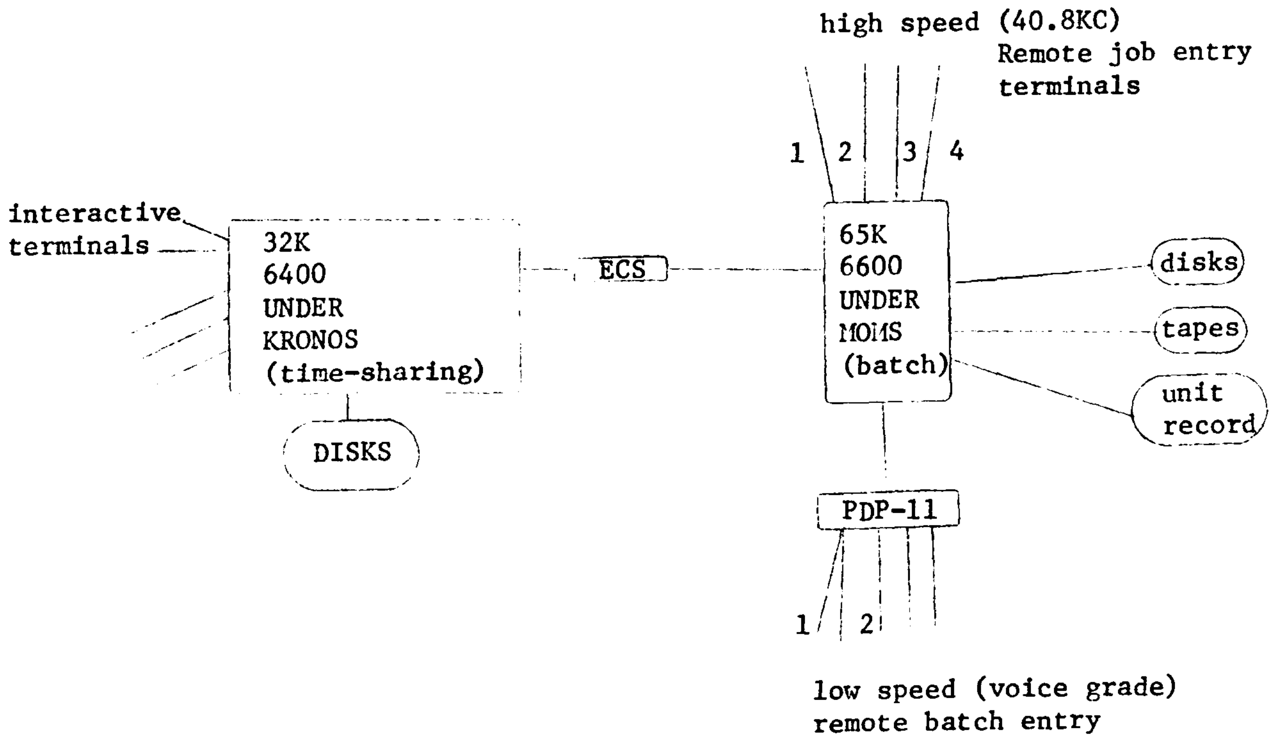
high speed (40.8KC)
Remote job entry
terminals
1
2
3
4
interactive
terminals
32K
6400
UNDER
KRONOS
(time-sharing)
ECS
65K
6600
UNDER
MOMS
(batch)
disks
tapes
unit
record
DISKS
PDP-11
1
2
low speed (voice grade)
remote batch entry

Figure 1

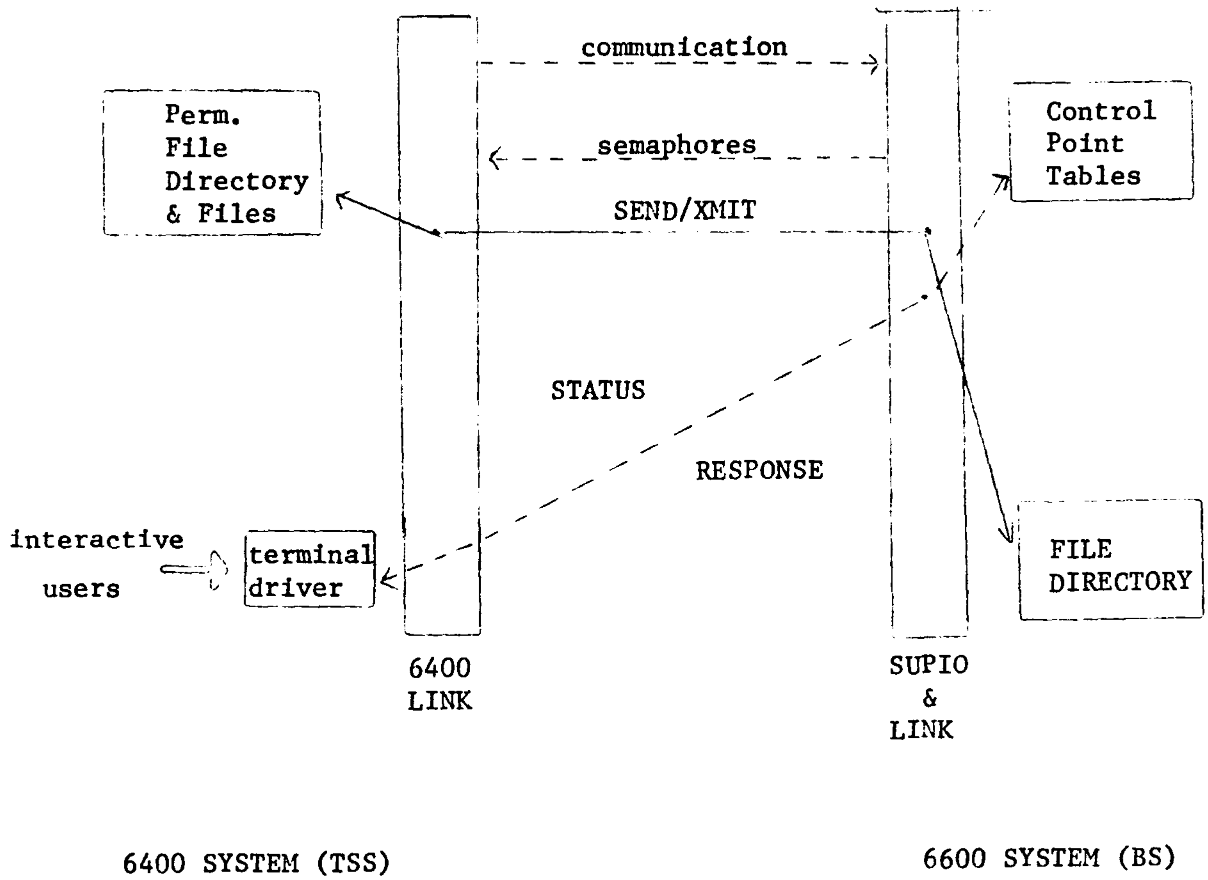
communication
semaphores
SEND/XMIT
Perm.
File
Directory
& Files
Control
Point
Tables
STATUS
RESPONSE
interactive
users
terminal
driver
FILE
DIRECTORY
6400
LINK
SUPIO
&
LINK
6400 SYSTEM (TSS)
6600 SYSTEM (BS)

Figure 2

~2200_8	Semaphors and buffers for inter-machine file transfers
~50000_8	6400 peripheral and central processor program reservoir
~400000_8	6600 peripheral and central processor program reservoir
~320000_8	6600 application program scratch pad area

Figure 3