REVISION 1

TEN-SYS-3

MEMORANDUM

To: BBN TEN-SYS Group

From: T. R. Strollo

Subject: Terminal Service Routines

Date: 24 March 1969

The TEN-SYS terminal service routines will handle a variety of terminals including all models of teletypes as well as IBM "selectric" type terminals and the GE terminal, etc. The initial implementation of the MINI-SYSTEM will handle only models 33, 35 and 37 teletypes ASR or KSR, but will be implemented in such a way that terminal dependent functions, such as code translation operations, can be added easily.

1. TERMINAL I/O

Input/output to terminals will be done by programs via the file system similar to the SDS-940 character I/O operations for teletype input (CIO=Ø) and teletype output (CIO=1). The appropriate file name will be TERMINAL. The internal character set will be essentially 7 bit ASCII (see Fig. 1) with some exceptions. Significant deviation from the 940 teletype handling will be noted in the handling of carriage return. Namely, the system will normally echo carriage return as carriage return, line feed, and will input the character EOL (37_8) instead of carriage return. (A subsystem may choose to interpret V^c (EOL) as carriage return.) The system will translate (EOL) to carriage return, line feed for terminal output.

2. TERMINAL DEPENDENT CHARACTERISTICS

Half-duplex or full-duplex terminals: one status bit for each terminal will be the HDX/FDX specification.

Panic Characters on HDX/FDX Terminals

The character C^c will cause a panic return of control to the EXECUTIVE. If the character C^c is typed when the input buffer is not empty, it will be stored away as a "deferred" panic unless two successive C^c's are typed which will again be interpreted as an immediate panic.

The internal character set is a 7 bit set. The character ØØØ is used as filler code. 37_8 is an end of line code (CR-LF). The remaining 126 codes are those defined by 1967 ASCII as modified by DEC. They are consistent with our Anelex Line Printer.

	High 3 bits			
Low 5 bits	000	001	010	011
00		Δ	@	`
01	SOH	!	A	a
02	STX	"	B	b
03	ETX	#	C	c
04	EOT	$	D	d
05	ENQ	%	E	e
06	ACK	&	F	f
07	BEL	'	G	g
10	BS	(	H	h
11	HT	)	I	i
12	LF	*	J	j
13	VT	+	K	k
14	FF	,	L	l
15	CR	-	M	m
16	SO	.	N	n
17	SI	/	O	o
20	DLE	Ø	P	p
21	DC1	1	Q	q
22	DC2	2	R	r
23	DC3	3	S	s
24	DC4	4	T	t
25	NAK	5	U	u
26	SYN	6	V	v
27	ETB	7	W	w
30	CAN	8	X	x
31	EM	9	Y	y
32	SUB	:	Z	z
33	ESC	;	[	{
34	FS	<	\	|
35	GS	=	]	}
36	RS	>	↑	~
37	EOL-US	?	←	DEL

INTERNAL CHARACTER SET

Figure 1.

With half-duplex terminals, the above is also true, but a method is provided to abort the output character stream by causing output to be suspended if an "echo-check" indicates the echo input character was not the same as the output character. Output will be suspended for 5 seconds during which time the user may type C^c if he wants to panic. At the end of this 5 second period, output will be re-enabled.

Paper Tape Readers on Terminals

Many terminals provide paper tape readers. The system will provide two alternative methods for reading paper tapes via these readers.

Method 1 (for FDX ASR terminals only):

On a full duplex terminal, it is simply necessary to output XON or to depress start reader to read in a paper tape. The system will detect the condition input buffer nearly full and characters being input at highest rate for that terminal. If this condition is true an XOFF is transmitted and a flag (XOVFLG) is set to remember this event. When the input buffer subsequently becomes nearly empty and this flag (XOVFLG) is set, an XON is transmitted. All characters input get handled as though they were typed in. Note this means CR gets input as EOL and echoed as CRLF. However, most paper tapes will contain CRLF which means EXTRANEOUS LF's WILL GET INPUT by this method.

Method 2 (for any ASR terminal, FDX or HDX):

A separate file name will mean terminal paper reader (e.g., TERM-PTR). If the user specifies input from this file, an XON is transmitted and the XON, XOFF sequences mentioned above are transmitted to FDX terminals. For HDX terminals only specially prepared tapes (see TERM-PTP) can be used. In all cases the sequence CRLF is echoed as CRLF, but the character EOL is input to the computer. This mode filters out the extraneous line feeds.

If the user specifies the file name TERM-PTP for output, first leader (CR CR CR CR...) is punch-typed, every N characters an XOFF is punch-typed, when the file is closed trailer (CR CR CR CR...) is punch-typed. When the computer reads an XOFF the same XOVFLG is set. On either an FDX or HDX terminal input buffer nearly empty and XOVFLG set causes XON to be transmitted. Note that on an HDX terminal the XOVFLG set means the character has been seen and echoed locally. It is also not possible to output to an HDX terminal while it is reading input from paper tape until the XOVFLG gets set.

Input Buffer Overflow

For FDX terminals, input buffer full and any character typed in causes an immediate typeout of 'G' (bell).

X, Y Paper Position

The system calculates the X,Y position of the paper in the terminal from the known ΔX, ΔY motion caused by typing characters and format affectors.

Horizontal Tab

The system has a flag for each terminal which states whether the terminal has a mechanism for horizontal tabs. It is always assumed that these tabs are preset to a specified horizontal stop. The system software tab settings are preset to these same stops. If the system outputs a tab and the software tab settings are consistent with the preset stops, and the terminal has a horizontal tab mechanism, the tab is output directly. In all other cases, the tab is simulated by multiple spaces. If the user outputs > max character count per line (usually 72), the system will output CRLF %%%%%, then the character and then increment the line number.

Tab Settings

Three 36 bit words per line specify the tab settings. A bit represents each space on the line (maximum terminal paper width is 36 x 3 = 108 characters). A 1 means there is a tab stop at that position, a Ø means there is no tab stop.

Vertical Tab and Form Feed

Vertical tab and form feed are handled much like HT. Preset VT positions are assumed. The system will normally print through the paper folds unless programs explicitly transmit L^C. A system flag indicates whether the terminal has a VT/FF mechanism or whether software simulation by multiple LF is necessary.

Upper and Lower Case

A flag will indicate whether the terminal has UC/LC letters. If it has only the upper case set, output of LC characters get translated to equivalent UC character. The input of LC letters will be (optionally) translated to UC internal codes for compatibility with UC only subsystems.

Terminal Dependent Specifications

A program will change terminal specification by the execution of an appropriate JSYS specifying a terminal line # (e.g., scanner line) and a flag word. An EXEC command will also conveniently translate English text to a call to this JSYS. The system will assume a "detached line" is whatever flavor of terminal the best available apriori information indicates. The system will not automatically update this apriori information every time a JSYS specifying new terminal type is executed.

3. TERMINAL I/O CONTROL

Echo Modes

The PDP-10 system will admit of a number (16) of echo modes. These modes are defined by the low order 4 bits of word Ø of the wake up declaration. We currently have defined 3 of the 16 modes. To understand these modes it is best to define some terms.

Immediate echoing: this is done either when the character is typed or if the terminal is output active it is done when there is a transition to not output active.

Deferred echoing: this is done at the time the character is read by the program.

Echo Modes

00_4: no echoing; useful for password input

01_4: immediate until wake struck then deferred. Characters will be immediately echoed per definition until a wake-up character is struck. From then until the next time the program is blocked for terminal input the echo mode will be deferred.

02_4: Both immediate and deferred if not blocked for input. If the program is not blocked for input, is not inputting, or is not outputting, the characters will be echoed immediately. They will also be echoed when passed to the program.

ECHO AND INPUT TRANSLATION CONTROL FLAGS

	CODE	STATE Ø	STATE 1
1)	CR-LF	CR is echoed as CR/LF (EOL into buffer) LF is echoed as LF	No Echo CR into buffer
2)	HT	If device has mechanical HT, echo HT; if not, simulate it	No Echo
3)	SI, SO (Red/black)	If device has red/black ribbon, echo the code, otherwise 'N' or 'O'	No Echo
4)	XON, XOFF	If device has paper tape, echo code, otherwise, 'Q', 'S'	No Echo
5)	Remaining control codes except bell (bell always echos bell)	'Equivalent letter'	No Echo
6)	DEL (RUB OUT)	No Echo	'RO'
7)	ESC (Alt mode)	No Echo	'$'
8)	SPACE	SPACE	No Echo
9)	LC letters	Echoed as UC [illegible] UC equivalent input to buffer	Echoed as themselves Input as themselves
10)	EOT	Never echoed as anything	
11)	All others are echoed as themselves.		

OUTPUT CONVENTIONS

1)	EOL	Becomes CRLF
2)	HT, VT, FF	Appropriate format action by simulation in some cases
3)	LC letters	If device has LC type LC letter or else UC letter
4)	All others	Output directly

WAKE UP CHARACTER SPECIFICATION PDP-1Ø

Wake up characters are defined by two 32 bit words (the remaining 4 bits in each word are used for other purposes). Each bit corresponds to a character or a group of characters (in internal code). A one (1) in the appropriate position will cause the terminal service routine to wake up the program when that code is typed in. Below is the encoding.

Bit Position	Word Ø Code(s)		Word 1 Code(s)	
0	01	(A^c)	41	!
1	02	(B^c)	42	"
2			43	#
3	04	(D^c)	44	$
4	05	(E^c)	45	%
5	06	(F^c)	46	&
6	07	(G^c)	47	'
7	10	(BS)	52	*
8	11	(HT)	53	+
9	12	(LF)	54	,
10	13	(VT)	55	-
11	14	(FF)	56	.
12	177	(DEL)	57	/
13	16	(RED)	72	:
14	17	(BLACK)	73	;
15	20	(P^c)	74	<
16	21	(Q^c)	75	=
17	22	(R^c)	76	>
18	23	(S^c)	77	?
19	24	(T^c)	100	@
20	25	(U^c)	134	\
21	26	(V^c)	136	↑
22	27	(W^c)	137	←
23	30	(X^c)	140	`
24	31	(Y^c)	174	¬
25	32	(Z^c)	176	|
26	33	(ESC) — terminal dependent	50, 133, 173	([{
27	34	(S4)	51, 135, 175	)]}
28	35	(S5)	60 - 67	0-7
29	36	(S6)	70, 71	8,9
30	37	(EOL)	101 - 132	A-Z
31	40	(SPACE)	141 - 172	a-z

Program Interrupts

A program may define a subset of characters from the set given below which when struck will cause a pseudo interrupt. The characters will not be put in the input buffer but will be echoed if the echo mode is immediate. To the service routine the characters are defined by a 36-bit word as follows:

Bit	Code	Meaning	Bit	Code	Meaning
0	01	SOH	18	23	DC3
1	02	STX	19	24	DC4
2			20	25	NAK
3	04	EOT	21	26	SYN
4	05	ENQ	22	27	ETB
5	06	ACK	23	30	CAN
6	07	BEL	24	31	EM
7	10	BS	25	32	SUB
8	11	HT	26	33	ESC
9	12	LF	27	34	FS
10	13	VT	28	35	GS
11	14	FF	29	36	RS
12	177	DEL	30	37	EOL-US
13	16	SO	31	41	!
14	17	SI	32	42	"
15	20	DLE	33	44	$
16	21	DC1	34	73	;
17	22	DC2	35	77	?

There will be a 36 bit terminal interrupt status word to say which of the above caused the pseudo-interrupt.

4. LINE EDITING

The system will provide simple line editing features to correct mistyping. If the system is using EOL as the wake up condition, the terminal service routines will permit single character deletion, total line deletion or total line retype.

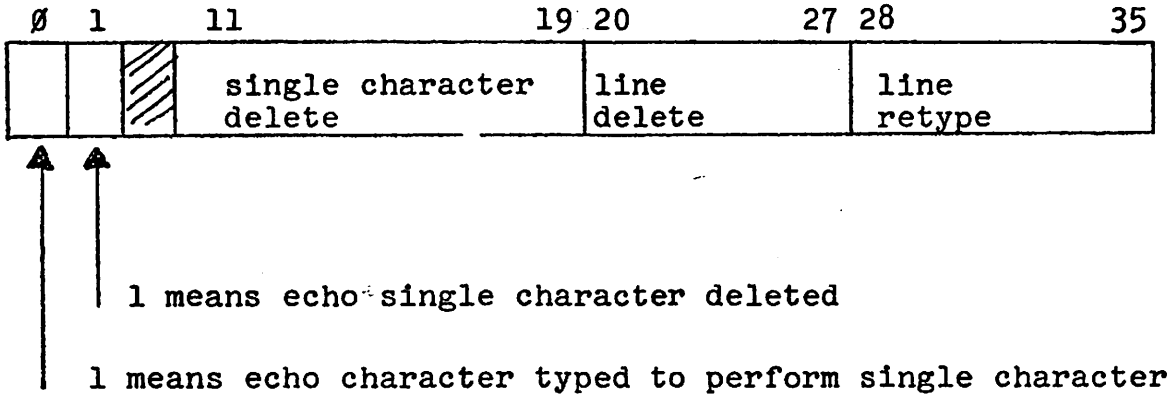
The program can specify the actual characters to use for each operation as well as for single character deletion.

a) whether to echo the character typed to perform deletion.

b) whether to echo the character deleted

For line deletion:

a) what to echo (up to 5 characters) on line deletion.



It is believed this versatility will keep everyone (even Telcomp) happy.

5. TERMINAL LINKS

The link strategy will be similar to the 940 link structure but somewhat more restricted to permit links amongst a large number (1000) of terminals without the resident core requirements of the 940 structure (goes up as N^2). Instead it will be possible for terminals to have output links only, and each terminal may be relative linked to only one other terminal. This terminal may also be relative linked to another terminal. This relative linking terminal to terminal may proceed to reasonable depth. All echoes and output to linked terminals will be done at "UUO" or "JSYS" execution time, not at interrupt level. (It turns out it is not useful to be able to output link to all terminals simultaneously, even for sending global messages because of REFUSE MESSAGE status and busy outputting status.)

6. "BIG BUFFER" IMPLEMENTATION

In order to reduce the amount of time spent processing terminal interrupts, as character interrupts are received (input or output) minimal operations are performed at interrupt level. All input characters are simply DATAI'd (this includes terminal line no.) into a global input buffer with any immediate, direct echoing done in the interrupt routine. More complicated echoing including links are handled by an outer-level routine which runsaas a scheduled job with fiarly high scheduler priority but at non-interrupt level. Before the character interrupt is dismissed, a request to schedule this outer-level routine will be placed on one of the scheduler queues.