A User TELNET
Description of an Initial Implementation

PREFACE

   The User TELNET described in this document has been implemented
   within UCSB's Online System by Mark Krilanovich and makes teletype-
   compatible time-sharing systems in the Net accessible to Online
   System users.

Contents

FIGURES

I. Function

   This document describes a program whose function is to make an Online
   System terminal _appear_ to any teletype-compatible, time-sharing
   system in the Network _as if it were directly connected to that
   system_. By invoking this program from his terminal, an OLS user can
   effectively dial up a system at another site and use it as if he were
   a local user of that system. The program performs the following
   major functions:

      1) it resolves keyboard and display device incompatibilities

      2) performs character set transformations, and

   3) makes its presence and that of the Network transparent to the
      user.

The program which performs these functions is called a _User TELNET_.
It operates in conjunction with another program called a _Server
TELNET_ executing at the site whose system is being used. A Server
TELNET exists at each site whose system is accessible from the Net.
Similarly, a User TELNET must exist at a site before users at that
site have access to remote systems.

User and Server TELNETs access the Net through their respective NCPs,
and operate under a Network-standard protocol which specifies the
hand-shaking procedure by which the two parties connect themselves to
one another, as well as the format of data sent over a pair of
Network connections established between them. A User TELNET makes
such protocol considerations transparent to its users.

The TELNET protocol is based upon the notion of a virtual teletype,
employing a 7-bit ASCII character set. The primary function of a
User TELNET, then, is to provide the means by which its users can
'hit' all the keys on that virtual teletype. If the user's keyboard
happens in fact to actually be a teletype, then the mapping procedure
is a very simple one. However, in UCSB's case, where a user's input
device is an OLS keyboard (a device very different from a teletype),
the mapping is more complex.

The primary function of a Server TELNET is to map the keys on the
virtual teletype into that set of keys _its_ local users can push on
their keyboards. Again, if those keyboards are teletypes, the
mapping done by the Server TELNET is straightforward. In other
cases, the task may be very complex.

A similar set of mappings transforms ouput generated by the remote
system into a form displayable on the user's output device (in UCSB's
case, this device is normally a storage scope).

II. Invoking TELNET

This and succeeding sections describe a preliminary version of a User
TELNET (hereafter referred to simply as TELNET) currently implemented
within the Online System. This initial implementation does not
provide all of the services that a final version must provide, nor
does it provide all the conveniences that the next version will
offer. It's a first pass which will be upgraded in the near future.

TELNET is accessible from NET, a subsystem (like MOLSF and COL) of
OLS. A user is by default prohibited from loading NET. To have
access to NET enabled fro his user number, a user need only contact
the Computer Center. Assuming the foregoing, Net can be loaded with
the key sequence:

    KEYBOARD ENTRY   OLS QUERY/RESPONSE
    SYST   WORK AREAS UPDATED
    LOAD NET   LOAD NET
    RETURN   FILE LOADED

or by specifying the system name 'NET' at login.

Once in NET, TELNET is invoked by going to Level II Real and hitting
LOG. TELNET responds with a query for site number. The user
should enter in decimal the number of the site (as indicated in
Figure 1) to which he desires access, followed by _RETURN_. TELNET
will then query the user for the Server TELNET's socket_number. By
convention, this number is normally 1, but in certain cases some
other socket may be appropriate. In any case, the user should enter
the socket number in decimal and hit _RETURN_. The dialogue, then,
goes like this:

    KEYBOARD ENTRY   OLS QUERY/RESPONSE
    II LOG   FOREIGN SITE NO. = (site number)
    site number RETURN   FOREIGN SCK NO. = 1
    1 RETURN

When the second RETURN is depressed, TELNET will attempt to contact
the designated Server TELNET and establish a duplex connection for
the user. Once the connection has been established, TELNET will
erase the tube and position the carriage to the upper left-hand
corner of the screen. From this point on, the user is effectively
connected to the remote system. TELNET enters a mode in which keys
pushed by the user are mapped into their virtual-teletype equivalents
and incoming text similarly transformed and displayed on the scope.
If the remote system to which the user is connected normally issues a
login message, that message will be the first to be displayed. In
any case, the user should proceed by logging in to the remote system
according to the conventions appropriate to that system.

Figure 1.

Network Sites

Institution	Location	Computer	Site Name	Site # (HEX)	Site # (DEC)
UCLA	Los Angeles	Sigma-7	UCLA	01	1
UCLA	Los Angeles	IBM 360/91	UCL1	41	65
Stanford Research Institute	Menlo Park	PDP-10	SRI0	02	2
Stanford Research Institute	Menlo Park	PDP-15	SRI1	42	66
UCSB	Santa Barbara	IBM 360/75	UCSB	03	3
University of Utah	Salt Lake City, Utah	PDP-10	UTAH	04	4
Bolt, Beranek, and Newman	Cambridge, Mass.	PDP-10	BBN0	05	5
Bolt, Beranek, and Newman	Cambridge, Mass.	DDP-516	BBN1	45	69
MIT	Cambridge, Mass.	GE 645	MIT0	06	6
MIT	Cambridge, Mass.	PDP-10	MIT1	46	70
Rand Corporation	Santa Monica	IBM 1800 (IBM 360/65)	RAND	07	7
System Development Corporation	Santa Monica	DDP-516 (IBM 360/67)	SDC	08	8
Harvard University	Cambridge, Mass.	PDP-10	HRV0	09	9
Harvard University	Cambridge, Mass.	PDP-1	HRV1	49	73

Lincoln Laboratory (MIT)	Lexington, Mass.	IBM 360/67	LIN0	0A	10
Lincoln Laboratory (MIT)	Lexington, Mass.	TX2	LIN1	4A	74
Stanford University	Stanford	PDP-10	STAN	0B	11
University of Illinois	Urbana, Ill.	PDP-11	ILl	0C	12
Case Western Resevrve University	Cleveland, Ohio	PDP-10	CASE	0D	13
Carnegie-Mellon University	Pittsburgh, Pa.	PDP-10	CARN	0E	14
Burroughs	Paoli, Pa.	B-6500 (Illiac IV)	BURR	0F	15

III. The Virtual Teletype

   The algorithm by which TELNET maps the OLS keyboard into the virtual
   teletype's character set, and by which it maps that same character
   set into the set of characters which can be displayed on the user's
   storage scope is defined in Figure 2. A line of that figure reads as
   follows:

      For line 11:

      The key labeled 'LF' (meaning 'Line Feed') on the virtual
      teletype, sometimes referred to as 'control-J', is struck by
      pressing either _SUB_, _CASE J_, or [1] on an OLS keyboard.
      TELNET sends to the remote system an 8-bit character with the
      value X'0A'. Whenever 'LF' is received from the foreign system,
      TELNET displays it by rolling the carriage down one line.

   As indicated in the figure, _CASE_ substitutes for the CNTRL key on a
   teletype. Hence, for example, 'control-C' is represented by the key
   pair 'CASE C'. Note, however, that _CASE_ and 'C' are hit in
   sequence, whereas on a teletype the CNTRL key is held down while 'C'
   is struck. 'CASE A' - 'CASE Z' each have an equivalent on the upper
   keyboard, and the position of that key on the upper keyboard
   corresponds to that of its counterpart on the lower keyboard. Hence,
   LS equivalent to CASE A.

Although TELNET provides the user with the means for transmitting
both upper- and lower-case alphabetics (hitting 'A' sends a lower-
case 'A'; holding down _SHIFT_ and hitting 'A' sends upper-case 'A'),
there is no provision in OLS for displaying lower-case characters on
the storage scope. Hence, TELNET maps lower-case alphabetics into
upper-case before displaying them.

The four virtual teltype keys 'ENQ', 'ACK', 'BEL', and 'NAK' are
displayed by TELNET in a special manner. Two lines are reserved for
these characters at the top of the display area, and whenever TELNET
receives such a character from the remote system, it displays it in
its assigned position within the two-line field. TELNET always
positions those four characters at the top of the display area,
regardless of the user's current position on the scope, then returns
to it.

A storage scope has both positive and negative attributes relative to
a teletype. Display is much quieter on a scope than on a teletype.
However, the noise made by the return of a teletype carriage is often
a valuable cue to the user, frequently signifying that the previous
line of input from the user has been accepted by the system. As a
substitute for this particular cue, TELNET displays an underline
('_') at the left edge on the next line whenever it receives a
carriage return (CR) from the remote system.

Figure 2.   TELNET Character Set

To Send	(Explanation)	Also Known as	Push Either	Or	Code Sent is (in hex)	Upon receipt Displayed as
NUL	NULL	^@	[2]		00	
SOH	Start of Heading	[3]^A	LS	[4]CASE A	01	
STX	Start of Text	^B	ATAN	CASE B	02	
ETX	End of Text	^C	LOG	CASE C	03	
EOT	End of Transmission	^D	REFL	CASE D	04	
ENQ	Enquiry	^E	[4]	CASE E	05	[5] <ENQ>
ACK	Acknowledge	^F	UP	CASE F	06	<ACK>
BEL	Bell	^G	DOWN	CASE G	07	<BELL>

BS	Backspace	^H	EVAL	CASE H	08	
HT	Horizontal Tab.	^I	INV	CASE I, TAB	09	
LF	Line Feed	^J	SUB	CASE J, [1]	0A	Carriage rolled down
VT	Vertical Tab.	^K	MAX	CASE K	0B	
FF	Form Feed	^L	MOD	CASE L	0C	
CR	Carriage Return	^M	DEL	CASE M, RETURN	0D	[6]Carriage returned
SO	Shift Out	^N	ARG	CASE N	0E	
SI	Shift In	^O	DIFF	CASE O	0F	
DLE	Data Link Escape	^P	SUM	CASE P	10	
DC1	Device Control 1	^Q	[7]	CASE Q	11	
DC2	Device Control 2	^R	[8]	CASE R	12	
DC3	Device Control 3	^S	RS	CASE S	13	
DC4	Device Control 4	^T	SQ	CASE T	14	
NAK	Negative Acknowledge	^U	CONJ	CASE U	15	<NAK>
SYN	Synchronous Idle	^V	EXP	CASE V	16	
ETB	End of Transmission Block	^W	[9]	CASE W	17	
CAN	Cancel	^X	COS	CASE X	18	

EM	End of Medium	^Y	SQRT	CASE Y	19	
SUB	Substitute	^Z	SIN	CASE Z	1A	
ESC	Escape	Alt Mode, ^[	NEG		1B	
FS	File Separator	^	PROD		1C	
GS	Group Separator	^]	SORT		1D	
RS	Record Separator	^^	CONV		1E	
US	Unit Separator	^<-	PWR		1F	
SP	Space		SPACE		20	blank
!	Exclamation Point		!		21	!
"	Quotation Marks	Diaeresis	"		22	"
#	Number Sign		#		23	#
$	Dollar Sign		$		24	$
%	Percent		%		25	%
&	Ampersand		&		26	&
'	Apostrophe	Acute Accent, Closing Single Quote	'		27	'
(	Opening Parenthesis		(		28	(
)	Closing Parenthesis		(		29	(
*	Asterick		*		2A	*

+	Plus		+		2B	+
,	Comma	Cedilla	,		2C	,
-	Hyphen	Minus	-		2D	-
.	Period	Decimal Point	.		2E	.
/	Slant		/		2F	/
:	Colon		:		3A	:
;	Semicolon		;		3B	;
<	Less than		<		3C	<
=	Equals		=		3D	=
>	Greater than		>		3E	>
?	Question Mark		?		3F	?
@	Commercial At		@		40	@
[	Opening Bracket		[		5B	[
\	Reverse Slant		CASE /		5C	\
]	Closing Bracket		]		5D	]
^	Circumflex		^	^	5E	^
_	Underline		<-	_	5F	_
`	Grave Accent	Opening single quote	CASE `		60	`
{	Opening Brace		CASE (		7B	{
|	Vertical Line		|		7C	|
}	Closing Brace		CASE)		7D	}

~	Tilde	Overline, General Accent	-		7E	~
DEL	Delete	Rubout	BACK		7F	
0-9	Numerics		0-9		30-39	0-9
A-Z	Upper Case Alphabetics		SHIFT [9] A-Z		41-5A	A-Z
a-z	Lower Case Alphabetics		A-Z		61-7A	A-Z

Table Notes

    [1] Down arrow
    [2] Superscript 1
    [3] Superscript 2
    [4] Circle with Dot in the Middle
    [5] Superscript 3
    [6] Superscript 6
    [7] Circle with Plus (+) in the Middle
    [8] Circle with Slash (/) in the Middle
    [9] Superscript 5

Notes for Figure 2. TELNET Character Set

Superscript 1 - All of the following keys send NULL:

             SET, CLR, cent sign, Superscript 0-9

Superscript 2 - '^A' is read 'Control A'. Same for '^B', '^C', etc.

Superscript 3 - ENQ, ACK, BEL, and NAK are displayed as '<ENQ>',
             '<ACK>', '<BELL>', and '<NAK>', respectively, in an
             area at the top of the screen reserved especially for
             those characters.

Superscript 4 - ^A is sent by hitting th keys 'CASE' and 'A' in turn.
             Same for ^B, ^C, etc.

Superscript 5 - Upper case 'A' is sent by holding down the SHIFT key
             while 'A' is struck. Same for upper case 'B', 'C',
             etc.

Superscript 6 - CR also causes an underline '_' to be displayed in
               the left margin as a substitute for the often useful
               cue provided by the noisy return of a teletype
               carriage.

A storage scope is also a much faster display device than a teletype.
However, in some situations this apparent attribute can be
troublesome. In particular, when a system displays a whole series of
lines of text without requiring input from the user, the display may
be wrapped around from the bottom of the scope to the top, and begin
overlaying itself before the user has had some time to read it all.
In such cases, the following strategy is sometimes useful (and will
make sense once the next section -- Section IV -- has been read): hit
_II_ before the display begins to wrap around upon itself; the
display will stop. After the text has been read, erase the scope and
hit _LOG_ and display will resume.

If the user hits _ERASE_ while in TELNET, that key will have its
usual effect; it will have _no_effect upon the remote system.
However, because of a quirk in the current implementation of TELNET,
ERASE will have the one additional effect of causing the display of
incoming text to be suspended until another key on the virtual
teletype is struck. The user is thus cautioned against erasing the
scope while waiting for a response from the remote system. However,
the user can extricate himself from the situation described by
following the _ERASE_ with NUL on the virtual teletype.

IV. Returning to TELNET

The user can at any time escape from TELNET (and hence from the
remote system to which he is attached) by depressing a level key
(e.g., I, II,...,_SYST, TYPE, LIST_) or of course, by hitting
RESET. Any time thereafter, the user may return to TELNET by
hitting _II LOG_ (on NET) once again, and resume operation on his
remote system _exactly where he left off_. When _'II LOG'_ is
pressed this second time, instead of querying the user for site
number as before, TELNET will notice that the user is already
connected to a remote system and simply resume where _it_ left off.

After he escapes from TELNET and before he returns to it, the user
may engage himself in any other Online System activity short of
logging out but including changing systems, while still retaining the
option of subsequently returning to TELNET and resuming activity on
the remote system to which he remains connected. The user can
exploit this property of TELNET to obtain hard copy of a selected
portion of his dialogue with the remote system. The user simply
brings his system to the point at which a listing is thereby desired,
escapes from TELNET by hitting _'TYPE SEL' 1,4 RETURN'_, thereby

selecting the line printer as a secondary output device, and then
returns to TELNET by pressing _'II LOG'_. All subsequent
communication with the remote system will be recorded for eventual
output on the printer. Logging off of OLS while escaped from TELNET
causes the TELNET connection to be broken automatically by the
system.

V. Breaking TELNET Connections

   At any time while the user is in contact with TELNET, after the
   connection to the remote system has been established, the user may
   terminate that connection by hitting _'CON RETURN'_. TELNET will
   respond _'SOCKETS PURGED_'. \ subsequent call to TELNET (i.e., a
   subsequent instance of _'II LOG'_) will illicit the original query
   for remote site number. The user is then free to connect himself to
   another foreign system.

   The user is cautioned that breaking Network connections as just
   described is not necessarily equivalent to logging out of the remote
   system. Some Server TELNETs may, when they detect the breaking of
   connections, log the user off of their system; others may leave the
   user logged on. The user should be aware of the conventions of the
   systems he uses and, where appropriate, log himself off before
   breaking connections.

   The key sequence _'I DEL RETURN'_ will also terminate a TELNET
   connection, but all other connections that may have been previously
   established using the operators of Level I are closed as well.

VI. Abnormal Network Conditions

   While the user is in TELNET and attached to a remote system, TELNET
   monitors the user's Network connections. If any abnormal condition
   is detected, it terminates its monitoring and issues a message of the
   form:

            {CONNECT}
            {INPUT}   ERROR - CODE = n
            {OUTPUT}

   where 'n' is one of the values listed in Figures 3-5. A CONNECT
   error may occur during TELNET's initial attempt to establish
   connections to the remote system; an INPUT error may occur when
   TELNET attempts to extract incoming data from the NET; and an OUTPUT
   error may occur as TELNET tries to insert outgoing data into the Net.

Figure 3. Connect Error Codes

4   -   A previous invocation of TELNET left a local receive
               socket open; the send socket is closed. Hit _'I DEL
               RETURN'_.

8   -   A previous invocation of TELNET aborted, and _'I DEL
               RETURN'_ failed to close the Network connections.
               The remote site is probably dead.

12   -   All communication paths between UCSB and the
               specified remote site are in use.

16   -   UCSB's NCP is running at capacity or is drained or
               stopped.

20   -   The connection attempt was refused by the remote
               site.

28   -   No such remote site.

36   -   Remote site was discovered to be dead.

44   -   The Operator has stopped or reset the NCP.

60   -   Either the specified remote site is not accepting
               input from the net, or there was a failure in the
               subnet.

68   -   The specified remote site has broken all existing
               connections to UCSB.

72   -   The remote site is known to be dead.

Figure 4. Input Error Codes

8   -   Connections to the server TELNET at the remote site
               have been broken.

16   -   Connections to the Server TELNET at the remote site
               are being broken.

52   -   An interrupt was sent by the remote system. Resume
               by hitting _LOG_.

Figure 5. Output Error Codes

8   -   Connections to the Server TELNET at the remote site
              have been broken.

16   -   Connections to the Server TELNET at the remote site
              are being broken.

20   -   same as 8.

36   -   Remote site has died.

44   -   The Operator has stopped or reset the NCP.

52   -   An interrupt was sent by the remote system. Resume
              by hitting _LOG_.

60   -   Either the remote site has stopped accepting input
              from the Net or there was a failure in the subnet.

64   -   same as 60.

68   -   The remote site has broken all existing connections
              to UCSB.