TELNET Protocol

This is a request for comment and is being distributed in advance of
the Atlantic City meetings for review and comment prior to or during
discussions on TELNET in preparation for issuing an official
document.

It is also being distributed so that selected installations planning
to implement early versions of TELNET will have a common basis for
such implementation.

The proposed document is the result of the work of the committee. It
represents a TELNET protocol felt to be adequate for initial
implementation. A few recent suggestions by committee members and
others have been incorporated where even though not thoroughly
cleared with all members, the chairman felt that they clarified the
protocol or would tend to simplify implementation but not
substantially change the agreed-upon approach.

Readers are referenced to the following previous releases of
information:

1. Conventions for Using an IBM 2741 Terminal or a User Console for
   Access to Network Server HOSTS
        Joel Winett, RFC 110 (NIC #5809)

2. Level III Server Protocol for the Lincoln Laboratory 360/67 HOST
        Joel Winett, RFC 109 (NIC #5808)

3. First Cut at a Proposed TELNET Protocol
        J. Melvin, D. Watson, RFC 97 (NIC #5740)

4. ASCII Format for Network Interchange
        V. Cerf, RFC 20 (NIC# 4722)

Another RFC will be distributed prior to the Atlantic City Meetings
containing many of the arguments supporting the proposal.

TELNET PROTOCOL

A Proposed Document

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TELNET is a third-level protocol, the function of which is to make a
terminal (or process) at a using site appear to the system or a
process at a serving site as logically equivalent to a terminal
"directly" connected to the serving site. In performing this
function, the protocol attempts to minimize the amount of information
each HOST must keep about the characteristics of other HOSTS.

Definitions

Protocol Levels (see Figure 1)

   Level 1

      HOST-IMP protocol specified by BBN in NIC 5735, Specifications
      for the Interconnection of a HOST, and an IMP (BBN Report 1822)

   Level 2

      HOST-HOST protocol performed by NCPs as described in Document
      Number 1 (NIC 5413) and subsequent amendments, see RFC 107 (NIC
      #5806)

      One view of the NCP's function is that it takes information
      from the net and routes it to receiving processes via
      mechanisms internal to each HOST; conversely, processes use
      the NCP, via internal system calls, to have information
      routed to other processes in the net (via the other
      processes' NCPs).

   Level 3 (see Figure 2)

      Level 3 is, by definition, the place to which and from which
      the NCP communicates internally in its own host.

      This level may be equivalent to the user process level in
      some systems, but this may not be the case in all systems.
      In using sites, the TELNET process operates at this level.
      In serving sites, the TELNET server operates at this level.

Initial Connection Protocol (ICP)

   An agreed-upon sequence of level 3 exchanges between two processes
   which is, in general, used to synchronize the dialogue between the
   processes, e.g., RFC 80 (NIC #5608) #1.

Serving Site

   The HOST into which the TELNET process is directing the user's
   keyboard input and from which the TELNET process is receiving
   control information and data effecting the user's terminal. At
   the serving site, a TELNET server is executing.

Using Site

   The HOST in which the TELNET process is executing.

Sending Site

   The HOST transmitting data, could be either using site or serving
   site.

Receiving Site

   Converse of sending site.

User

   The person or process "driving" the TELNET process.

In providing services the TELNET protocol will use established
network conventions, specifically the Network Control Program, and
Initial Connection Protocol referenced in the above definitions.

The TELNET protocol provides for a Network Virtual Terminal (NVT)
through which users may transmit and receive data over connections
between the using site and the serving site.

The code of the NVT will be full ASCII. The seven-bit code will be
transmitted in eight-bit bytes, the high order bit set to zero.

It will be the responsibility of the using site to provide its users
with a means of producing all 128 ASCII codes, as well as a selected
set of special TELNET control signals (see Figure 3).

The ASCII character ESC will be employed by the user as an escape
signal indicating that the next character(s) has special meaning.
The meaning assigned to escape code will be serving site defined and
therefore may not be consistant across the network.

It will be the responsibility of the serving site to specify for
users how the NVT code will be used to represent the codes normally
generated by a local terminal. The serving sites specification of
this representation is expected, where reasonable, to map on a one-
for-one basis for ASCII graphics and controls that are provided
through local terminals. The serving site will also specify how the
escape conventions will be interpreted by the system.

The end of a line will be represented in the NVT as carriage return
followed by line feed.

The protocol assumes that at initially the serving site will not
provide any echo to the using site.

Each TELNET control signal for which code must be sent over the
connection will be represented in the NVT by an eight-bit code, with
the high order bit set to one. Following are the special codes
established to date. (U) indicates that in most implementations the
user would be expected to have the ability to signal the TELNET
process from his terminal to initiate the code.

Code X'A0'

    Source: Both Sites (U)
    Meaning: A DATA TYPE[1] signal indicating that code will be
             transmitted by NVT, i.e., using the seven-bit ASCII
             conventions.

Code X'80'

    Source: Using Site (U)
    Meaning: Order using site NCP to send an INS and insert X'80' in
             data stream.

Code X'81'

    Source: Using Site (U)
    Meaning: Break or Attention

   Code X'82'

      Source: Serving System
      Meaning: Reverse Break

   Code X'83'

      Source: Both Sites
      Meaning: I Echo

   Code X'84'

      Source: Both Sites
      Meaning: You Echo

   Code X'85'

      Reserved

   Code X'86'

      Reserved

   Code X'87'

      Source: Both Sites
      Meaning: This site has not implemented the following control code.

   Code X'88'

      Source: Both Sites
      Meaning: [2]Return to control mode, i.e. next byte will be a
               control signal, possible a new DATA TYPE.

Some special TELNET control signals are required to permit the user
on some systems to send control information to the using site TELNET
process. These do not require a corresponding control code for
transmission. The local TELNET control signals are:

   1. Transmit all data to this point.
   2. Suppress transmission of end of line, send all other data.

Data is to be forwarded to the NCP for transmission as convenient,
but at least at the end of line, end of line suppression, and
transmit signals. If the normal line length of the sending site is
greater than the allocation given by the receiving site, the sending
sites TELNET process or TELNET server will be responsible for
breaking the line into convenient lengths and turning them over to
the NCP for transmission.

This document will be revised as necessary to provide conventions for
data types, in addition to the NVT ASCII type.

Footnotes:

[1] A one-byte DATA TYPE signal is sent as the first byte of data
over a connection. A default is employed if the first byte over a
connection has the high order bit set to zero, and it is assumed that
the seven-bit ASCII NVT convention will be employed. After initial
connection, the DATA TYPE may be changed (see code X'88'). Most
implementations and applications may expect the DATA TYPES to be
symmetrical at any point in time,(i.e. both using a serving site
using the same DATA TYPE.).

[2] A site receiving a DATA TYPE signal is to respond with a double
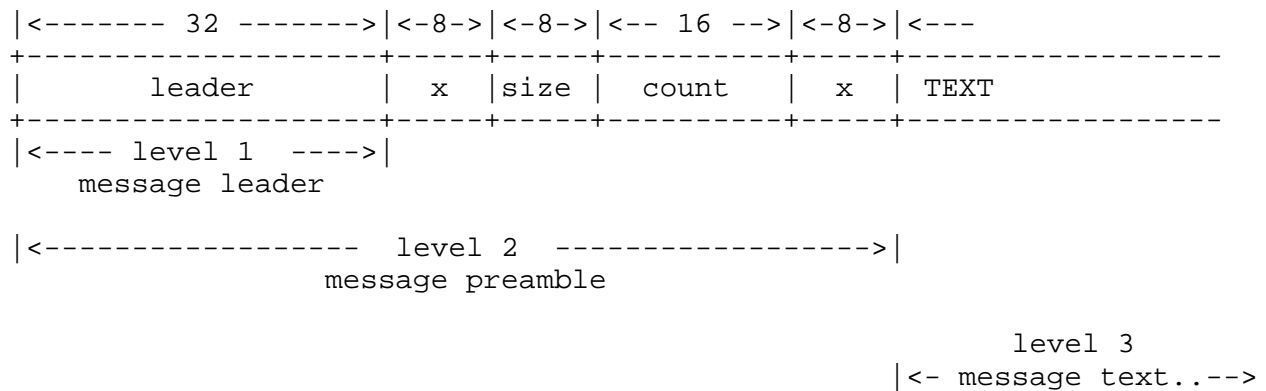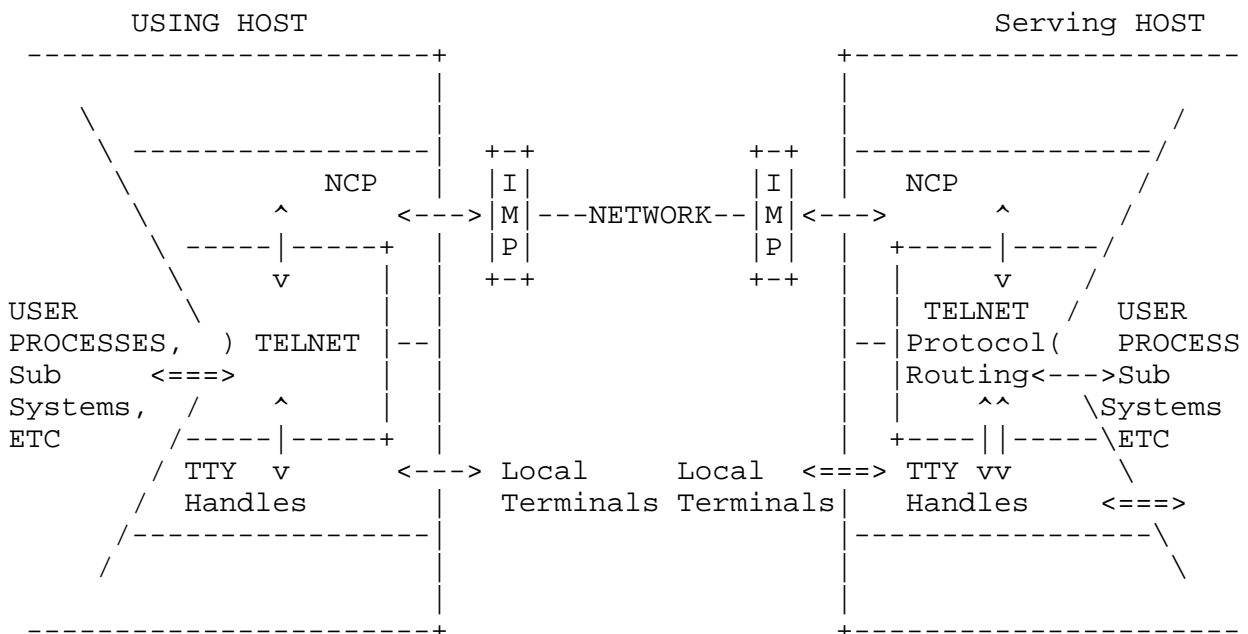X'88' if the new DATA TYPE is acceptable.

```
|<------- 32 ------->|<-8->|<-8->|<-- 16 -->|<-8->|<---
+-------------------+-----+-----+---------+-----+----------------
|      leader       |  x  |size |  count  |  x  | TEXT
+-------------------+-----+-----+---------+-----+----------------
|<---- level 1 ---->|
    message leader


|<----------------- level 2 ----------------->|
           message preamble


                                            level 3
                                 |<- message text..-->
```

                Figure 1. Network Message on Link 2-31
             Indicating Portions of Interest to Various Levels

```
         USING HOST                                    Serving HOST
    --------------------+                    +--------------------
                        |                    |
      \ ---------------|  +-+         +-+  |---------------/
       \      NCP      |  |I|         |I|  |    NCP       /
        \     ^    <--->|M|---NETWORK--|M|<--->    ^      /
         \ -----|-----+ |  |P|         |P|  | +-----|-----/
          \     v     | |  +-+         +-+  | |     v    /
    USER   \          | |                   | | TELNET  / USER
    PROCESSES,  ) TELNET |--|              |--|Protocol(   PROCESS
    Sub    <===> |   | |                   | |Routing<--->Sub
    Systems, /   ^   | |                   | |   ^^   \Systems
    ETC    /-----|-----+ |                 | +----||-----\ETC
        / TTY  v     <---> Local   Local  <===> TTY vv    \
       /  Handles    | Terminals Terminals| Handles   <===>
      /---------------|                    |---------------\
     /                |                    |                \
    /                 |                    |                 \
                      |                    |
    --------------------+                    +--------------------
```

<---> Current TELNET paths
<===> Candidate future TELNET paths

          Figure 2. Current and Candidate Future TELNET Paths

O'Sullivan   [Page 8]

```
+-----------------------------------+----+----+----+----+----+----+----+----+
|\ b8  ->                           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| \ b7  ->                          | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  |
|  \ b6  ->                         | 0  | 0  | 1  | 1  | 0  | 0  | 1  | 1  |
|B \ b5  ->                         | 0  | 1  | 0  | 1  | 0  | 1  | 0  | 1  |
| I +---+---+---+---+-----+----+----+----+----+----+----+----+----+----+
+ T | b | b | b | b |\COL->|    |    |    |    |    |    |    |    |
\  S| 4 | 3 | 2 | 1 | \    |    |    |    |    |    |    |    |    |
 \  |   |   |   |   |  |\  | 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
  \ |   |   |   |   |  v \ |    |    |    |    |    |    |    |    |
   \| v | v | v | v |ROW \ |    |    |    |    |    |    |    |    |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 0 | 0 | 0 |  0   |NUL |DLE | SP | 0  | @  | P  | \  | p  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 0 | 0 | 1 |  1   |SOH |DC1 | !  | 1  | A  | Q  | a  | q  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 0 | 1 | 0 |  2   |STX |DC2 | "  | 2  | B  | R  | b  | r  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 0 | 1 | 1 |  3   |ETX |DC3 | #  | 3  | C  | S  | c  | s  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 1 | 0 | 0 |  4   |EOT |DC4 | $  | 4  | D  | T  | d  | t  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 1 | 0 | 1 |  5   |ENQ |NAC | %  | 5  | E  | U  | e  | u  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 1 | 1 | 0 |  6   |ACK |SYN | &  | 6  | F  | V  | f  | v  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 0 | 1 | 1 | 1 |  7   |BEL |ETB | '  | 7  | G  | W  | g  | w  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 0 | 0 | 0 |  8   | BS |CAN | (  | 8  | H  | X  | h  | x  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 0 | 0 | 1 |  9   | HT | EM | )  | 9  | I  | Y  | i  | y  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 0 | 1 | 0 | 10   | LF |SUB | *  | :  | J  | Z  | j  | z  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 0 | 1 | 1 | 11   | VT |ESC | +  | ;  | K  | [  | k  | {  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 1 | 0 | 0 | 12   | FF | FS | ,  | <  | L  | \  | l  | |  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 1 | 0 | 1 | 13   | CR | GS | -  | =  | M  | ]  | m  | }  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 1 | 1 | 0 | 14   | S0 | RS | .  | >  | N  | ^  | n  | ~  |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
    | 1 | 1 | 1 | 1 | 15   | S1 | US | /  | ?  | O  | _  | o  |DEL |
    +---+---+---+---+------+----+----+----+----+----+----+----+----+
         Code Structure    8   7   6   5   4   3   2   1
                          --- --- --- --- --- --- --- --- --- ---
```

```
+------------------------------+----+----+----+----+----+----+----+----+
|\  b8  ->                     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
|  \  b7  ->                   | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  |
|    \  b6  ->                 | 0  | 0  | 1  | 1  | 0  | 0  | 1  | 1  |
|B  \  b5  ->                  | 0  | 1  | 0  | 1  | 0  | 1  | 0  | 1  |
| I   +---+---+---+---+--------+----+----+----+----+----+----+----+----+
+  T | b | b | b | b |\COL->  |    |    |    |    |    |    |    |    |
\   S| 4 | 3 | 2 | 1 |  \     |    |    |    |    |    |    |    |    |
 \   |   |   |   |   |   |\   | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 |
  \  |   |   |   |   |   v \  |    |    |    |    |    |    |    |    |
   \ | v | v | v | v |ROW \   |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 0 | 0 | 0 |   0    |'80'|    |'A0'|    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 0 | 0 | 1 |   1    |'81'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 0 | 1 | 0 |   2    |'82'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 0 | 1 | 1 |   3    |'83'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 1 | 0 | 0 |   4    |'84'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 1 | 0 | 1 |   5    |'85'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 1 | 1 | 0 |   6    |'86'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 0 | 1 | 1 | 1 |   7    |'87'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 0 | 0 | 0 |   8    |'88'|    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 0 | 0 | 1 |   9    |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 0 | 1 | 0 |  10    |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 0 | 1 | 1 |  11    |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 1 | 0 | 0 |  12    |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 1 | 0 | 1 |  13    |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 1 | 1 | 0 |  14    |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
     | 1 | 1 | 1 | 1 |  15    |    |    |    |    |    |    |    |    |
     +---+---+---+---+--------+----+----+----+----+----+----+----+----+
```

  'XX' = HEX designation for codes assigned to TELNET Control Signals.

            Figure 3. Official Network Virtual Terminal Code

[This RFC was put into machine readable form for entry]
[into the online RFC archives by Sergio Kleiman, 8/01]