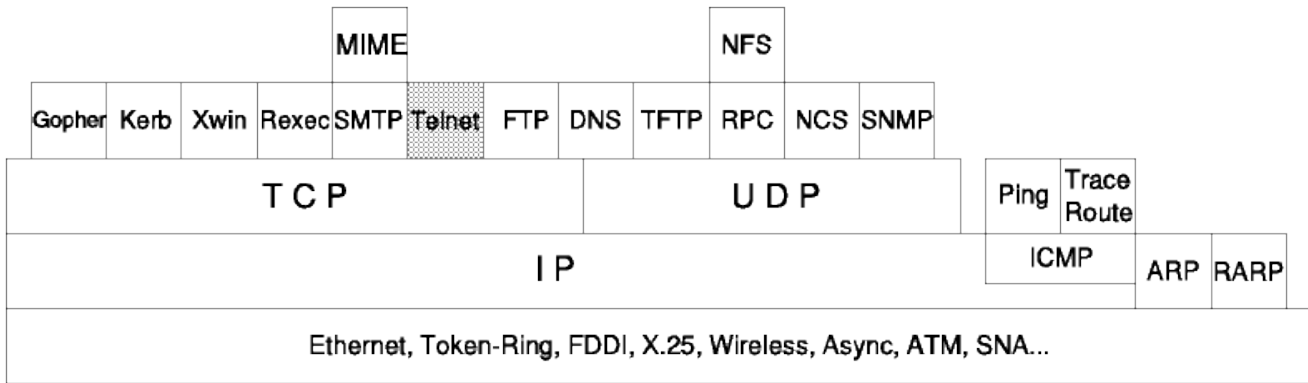# Telnet and the Telnet Protocol
(IBM Corporation)

Figure: TELNET - Remote Login Protocol

TELNET is a standard protocol with STD number 8. Its status is recommended. It is described in RFC 854 - TELNET Protocol Specifications and RFC 855 - TELNET Option Specifications.

The TELNET protocol provides a standardized interface, through which a program on one host (the TELNET client) may access the resources of another host (the TELNET server) as though the client were a local terminal connected to the server.

For example, a user on a workstation on a LAN may connect to a host attached to the LAN as though the workstation were a terminal attached directly to the host. Of course, TELNET may be used across WANs as well as LANs.
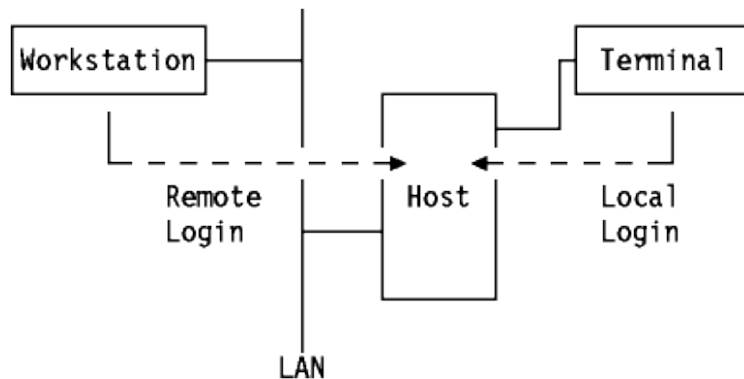

Figure: Remote Login using TELNET - TELNET allows the LAN-attached user to log in the same way as the local terminal user.

Most TELNET implementations do not provide you with graphics capabilities.

TELNET Operation
TELNET protocol is based on three ideas:

- The Network Virtual Terminal (NVT) concept. An NVT is an imaginary device having a basic structure common to a wide range of real terminals. Each host maps its own terminal characteristics to those of an NVT, and assumes that every other host will do the same.

- A symmetric view of terminals and processes

- Negotiation of terminal options. The principle of negotiated options is used by the TELNET protocol, because many hosts wish to provide additional services, beyond those available with the NVT. Various options may be negotiated. Server and client use a set of conventions to establish the operational characteristics of their TELNET connection via the ``DO, DON'T, WILL, WON'T'' mechanism discussed later in this chapter.

The two hosts begin by verifying their mutual understanding. Once this initial negotiation is complete, they are capable of working on the minimum level implemented by the NVT. After this minimum understanding is achieved, they can negotiate additional options to extend the capabilities of the NVT to reflect more accurately the capabilities of the real hardware in use. Because of the symmetric model used by TELNET, both the host and the client may propose additional options to be used.
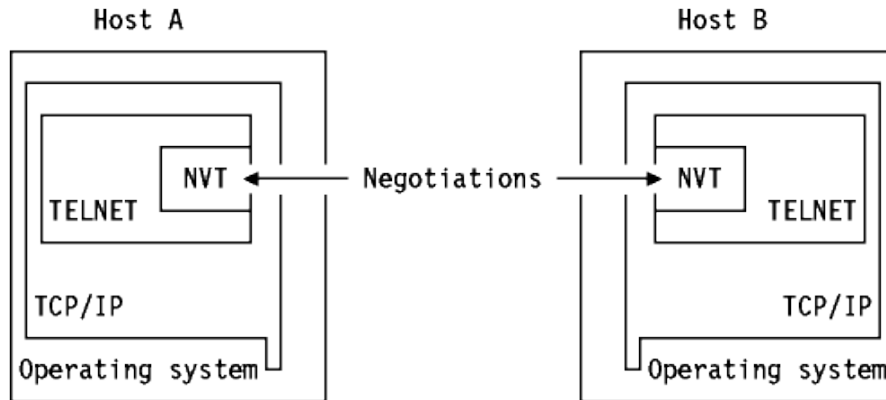

Figure: The Symmetric TELNET Model - The negotiations start on the NVT basis.

Network Virtual Terminal

The NVT has a printer (or display) and a keyboard. The keyboard produces outgoing data, which is sent over the TELNET connection. The printer receives the incoming data. The basic characteristics of an NVT, unless they are modified by mutually agreed options are:

- The data representation is 7-bit ASCII transmitted in 8-bit bytes.
- The NVT is a half-duplex device operating in a line-buffered mode.
- The NVT provides a local echo function.

All of these may be negotiated by the two hosts. For example, a local echo is preferred because of the lower network load and superior performance but there is an option for using a remote echo, although no host is required to use it.
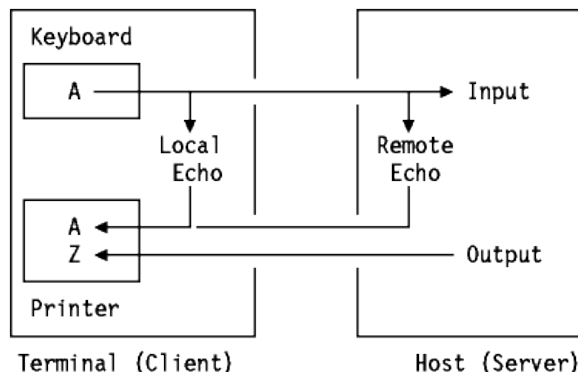

Figure: Echo Option - The remote echo function can be used instead of the local echo if both parties agree.

An NVT Printer has an unspecified carriage width and page length. It can handle printable ASCII characters (ASCII code 32 to 126) and understands some ASCII control characters such as:

Command	ASCII	Action
NULL (NUL)	0	No Operation.
Line Feed (LF)	10	Moves the printer to the next print line, keeping the same horizontal position.
Carriage Return (CR)	13	Moves the printer to the left margin.
BELL (BEL)	7	Produces an audible or visible signal.
Back Space (BS)	8	Moves the print head one character position toward the left margin.
Horizontal Tab (HT)	9	Moves the printer to the next horizontal tab stop.
Vertical Tab (VT)	11	Moves the printer to the next vertical tab stop.
Form Feed (FF)	12	Moves the printer to the top of the next page, keeping the same horizontal position.

TELNET Options

There is an extensive set of TELNET options, and the reader should consult STD 1 - Official Internet Protocol Standards for the standardization state and status for each of them. At the time of writing, the following options were defined:

Num	Name	State	RFC	STD
255	Extended-Options-List	Standard	861	32
0	Binary Transmission	Standard	856	27
1	Echo	Standard	857	28
3	Suppress Go Ahead	Standard	858	29
5	Status	Standard	859	30
6	Timing Mark	Standard	860	31
34	Linemode	Draft	1184	
2	Reconnection	Proposed		
4	Approx Message Size Negotiation	Proposed		
7	Remote Controlled Trans and Echo	Proposed	726	
8	Output Line Width	Proposed		
9	Output Page Size	Proposed		
10	Output Carriage-Return Disposition	Proposed	652	
11	Output Horizontal Tabstops	Proposed	653	
12	Output Horizontal Tab Disposition	Proposed	654	
13	Output Formfeed Disposition	Proposed	655	
14	Output Vertical Tabstops	Proposed	656	
15	Output Vertical Tab Disposition	Proposed	657	
16	Output Linefeed Disposition	Proposed	658	
17	Extended ASCII	Proposed	698	

Table: TELNET Options (Part 1 of 2)

Num	Name	State	RFC	STD
18	Logout	Proposed	727	
19	Byte Macro	Proposed	735	
20	Data Entry Terminal	Proposed	1043	
21	SUPDUP	Proposed	736	
22	SUPDUP Output	Proposed	749	
23	Send Location	Proposed	779	
24	Terminal Type	Proposed	1091	
25	End of Record	Proposed	885	
26	TACACS User Identification	Proposed	927	
27	Output Marking	Proposed	933	
28	Terminal Location Number	Proposed	946	
29	TELNET 3270 Regime	Proposed	1041	
30	X.3 PAD	Proposed	1053	
31	Negotiate About Window Size	Proposed	1073	
32	Terminal Speed	Proposed	1079	
33	Remote Flow Control	Proposed	1372	
35	X Display Location	Proposed	1096	
39	TELNET Environment Option	Proposed	1572	
37	TELNET Authentication Option	Experimental	1416	

Table: TELNET Options (Part 2 of 2)

All of the standard options have a status of recommended and the remainder have a status of elective. There is an historic version of the TELNET Environment Option which is not recommended; it is TELNET option 36 and was defined in RFC 1408.

Full-Screen Capability
Full-screen TELNET is possible provided the client and server have compatible full-screen capabilities. For example, VM and MVS provide a TN3270-capable server. To use this facility, a TELNET client must support TN3270.

TELNET Command Structure
The communication between client and server is handled with internal commands, which are not accessible by users. All internal TELNET commands consist of 2 or 3-byte sequences, depending on the command type.

The Interpret As Command (IAC) character is followed by a command code. If this command deals with option negotiation, the command will have a third byte to show the code for the referenced option.

```
 _____
| Interpret   | Command   | Option    |
| As          |           | Negotiated|
| Command     | Code      |           |
|_____|_____|_____|

    byte 1       byte 2      byte 3

Sample:

     255          253          24

      |            |            |
      |            |            |
      |            |            |
      |            |            |
      |            |            |->Terminal type
      |            |
      |            |->WILL
      |
      |-> IAC
```

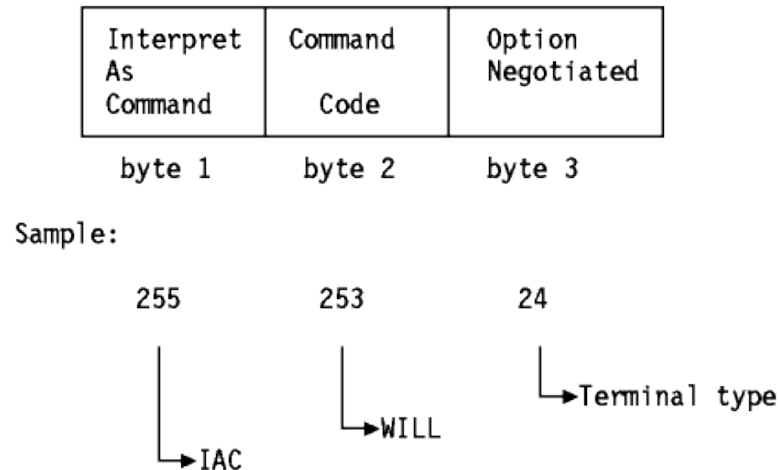**Figure: Internal TELNET Command Structure - This command proposes negotiation about terminal type.**

Command name	Code	Comments
SE	240	End of sub-negotiation parameters.
NOP	241	No operation.
Data Mark	242	The data stream portion of a synch. This should always be accompanied by a TCP urgent notification.
Break	243	NVT character BRK.
Go ahead	249	The GA signal.
SB	250	Indicates that what follows is sub-negotiation of the option indicated by the immediately following code.
WILL	251	Shows the desire to use, or confirmation that you are now using, the option indicated by the code immediately following.
WON'T	252	Shows the refusal to use, or to continue to use, the option indicated by the code immediately following.
DO	253	Requests that the other party uses, or confirms that you are expecting the other party to use, the option indicated by the code immediately following.
DON'T	254	Demands that the other party stop using, or confirms that you are no longer expecting the other party to use, the option indicated by the code immediately following.
IAC	255	Interpret As Command. Indicates that what follows is a TELNET command, not data.

Option Negotiation

Using internal commands, TELNET in each host is able to negotiate options. The starting base of negotiation is the NVT capability: each host to be connected must agree to this minimum. Every option can be negotiated by the use of the four command codes WILL, WON'T, DO, DON'T described above. In addition, some options have sub-options: if both parties agree to the option, they use the SB and SE commands to manage the sub-negotiation. Here is a simplified example of how option negotiation works.

Send	Reply	Meaning
DO transmit binary	WILL transmit binary	
DO window size	WILL window size	Can we negotiate window size?
SB Window Size 0 80 0 24 SE		Specify window size
DO terminal type	WILL terminal type	Can we negotiate terminal type?
SB terminal type SE		Send me your terminal characteristics.
	SB terminal type IBM-3278-2 SE	My terminal is a 3278-2
DO echo	WON'T echo	

The terminal types are defined in STD 2 - Assigned Numbers.

TELNET Basic Commands

The primary goal of the TELNET protocol is the provision of a standard interface for hosts over a network. To allow the connection to start, the TELNET protocol defines a standard representation for some functions:

- IP - Interrupt Process
- AO - Abort Output
- AYT - Are You There
- EC - Erase Character
- EL - Erase Line
- SYNCH - Synchronize

Implementations
VM

The TELNET client is a CMS program, that is, you must log on to a VM user ID running CMS to use it. The TELNET server runs in the TCP/IP virtual machine and uses the *CCS System service to create logical terminals for incoming TELNET clients. VTAM (GCS) is not required to use the TELNET protocol on a VM system.

Full-Screen Emulation

When you use the TELNET command to connect to a host, you have to choose the mode of operation. Line mode or transparent mode are the two possibilities. In line mode you will be connected as a start-stop TTY terminal. In transparent mode, the TELNET command supports IBM 3270-type display stations. Examples of stations are:

- IBM 3278 Display Station Models 2, 3, 4, and 5
- IBM 3279 Display Station Models 2, and 3.

The mode of operation depends on the ability of both hosts to agree on a terminal type.

Translate Tables

The translation tables used to convert EBCDIC data to ASCII do not always include desired characters. This becomes evident when you use the National Language Support Option (NLS) with your operating system. TCP/IP for VM provides standard tables. If needed, you can create and customize your own translate tables, without having to recompile the source. The TELNET CLIENT function only works in 7-bit mode. For more details, please refer to IBM TCP/IP Version 2 Release 3 for VM: Planning and Customization.

Command Format

`TELNET ( foreignhost ( portnumber ))(( linemode ) translate filename ))`

- Linemode - makes line mode instead of full-screen mode of connection.
- Translate - defines the translation table to be used.

While in a TELNET session, you may invoke subcommands such as:

- AO - stop display output
- AYT - query connection
- HELP - help
- IP - interrupt process
- PA1 - send PA1 keystroke
- QUIT - quit session
- SYNCH - clear data path

For more details, please refer to IBM TCP/IP Version 2 Release 3 for VM: User's Guide.

MVS

TELNET provides:

- Client and server 3270 full screen (transparent mode).

- Client and server line mode.

- Server for 3270 DBCS transfer mode which supports all full-screen access from a VT100 or VT282 remote TELNET client.

- Client VT100 and VT220 full-screen support with either Communication Subsystem For Interconnection (CSFI) from IBM or similar products from third-party vendors.

TELNET functionality:

- **Session Establishment** - When a 3270 connection is established, the MVS TELNET server allows you to choose which VTAM application a client will be automatically connected to (usually this default application is a network solicitor). If you want the incoming users to be able to choose between different VTAM applications (that is, you do not specify a default application), the TELNET server will ask for the application name. It is possible to restrict the use of an application to some users (or none) and to have logical units (LU) reserved for some specific users.

- **Unformatted system services (USS) message 10 support** - USS message 10 support provides the ability to emulate the VTAM USS message 10 support. You may define one or more USS

message 10 screens. The actual USS message 10 screen to be used for a TELNET session can be selected via the LU mapping functions.

- **IP address to LU name mapping** - The IP-address-to-LU-name mapping function provides for the selection of both an LU type 2 name and an application screen (or USS message 10 screen) for incoming TELNET sessions. The selection is made by the following:

  1. IP address
  2. Group of IP addresses
  3. Subnet
  4. Used link to the MVS host

- **Support for 3270 DBCS transform** - 3270 DBCS transform mode provides 3270 full-screen emulation where the 3270 protocol processing is performed entirely by IBM TCP/IP for MVS. The remote TELNET client may be emulating either a VT100 or VT282 type terminal.

- **SMF reporting** - The TELNET server also provides user accounting and control information using the MVS SMF (System Management Facility) records. For example, client identity, IP address, timestamp of LOGON and LOGOFF and VTAM LU can be recorded. A standard record type (SMF record type 118) has been registered.

- **Modify console command** - The console operator may now query the status of active or inactive LUs in use by the TELNET server.

- **User set limits** - The user set option permits the user to control the number of TCP connections or UDP ports that may be open at one time.

- **Binary option for line mode** - With this option the line mode client is able to bypass the ASCII to EBCDIC translation.

VTAM and TSO (refer to IBM TCP/IP Version 3 Release 1 for MVS: Customization and Administration Guide for more details about the requirements) are required to use TELNET (both client and server).

The capabilities of the TELNET function under MVS are the same as under VM.

A programmable workstation may use either a TN3270 client or an rlogin client to reach OpenEdition MVS services.

OS/400

The OS/400 TELNET provides both client and server functions. The OS/400 TELNET supports negotiations of the data transmission in one of the following four operating modes: VT100 full-screen mode, ASCII line mode, 5250 full-screen mode (see RFC 1205 for details) or 3270 full-screen mode.

- **VT100 mode considerations:**
  Although the AS/400 TELNET server supports VT100 clients, this is not the preferred mode to use. A TN3270 or TN5250 client is preferred. The VT100 terminal is a character mode device, while the OS/400 is a block mode system. In general, this results in larger amount of overhead associated with the transmission of each VT100 keystroke. In contrast, the 5250 or 3270 block devices buffer all keystrokes at the client system until an Attention Identifier (AID) key is pressed.

The OS/400 VT100 server requires the VT100 client to have the autowrap option turned on. The Change Keyboard Map (CHGKBDMAP) and the Set Keyboard Map (SETKBMAP) commands are available for keyboard remapping.

- **ASCII line mode considerations:**
  ASCII line mode is the standard TELNET network virtual terminal (NVT) support and is assumed when 5250 full-screen mode or 3270 full-screen mode cannot be negotiated. The client ASCII line mode provides one input line and several scrollable output lines. Since the OS/400 operates in full-screen mode and has screens with multiple input fields, this ASCII line mode TELNET server implementation has several considerations. For example, a sign-on screen for the AS/400 system is not automatically displayed when ASCII line mode is negotiated. Please refer to AS/400 TCP/IP Guide for details.

- **5250 full-screen considerations:**
  5250 full-screen support can only be satisfactorily negotiated with a TELNET application running on a system that supports 5250 TELNET. The client support is similar to the OS/400 display station pass-through between two OS/400 systems. A TELNET user at the client OS/400 will receive an OS/400 5250 sign-on display from the server system and will be able to run applications on the remote system as if the display were locally attached to the server.

  The OS/400 server TELNET requires virtual controllers and devices (which are automatically created by the system) to direct output on the client system. OS/400 server TELNET must be allowed to automatically configure virtual controllers and 5250 or 3270 devices.

- **3270 full-screen considerations:**
  3270 full-screen support is negotiated with any TELNET application that supports 3270 TELNET. The TELNET user at the local OS/400 receives a 3270 logon screen (for example, a VM logo screen) and is able to run applications on the 3270 host as if his display were locally attached. The 3270 TELNET server support allows the IBM S/370 family systems and non-AS/400 systems client TELNET users to sign on and run OS/400 5250 full-screen applications as if they were locally attached to the AS/400. Automatic configuration of controllers and devices is allowed. The OS/400 3270 full-screen mode TELNET server supports 3270 extended attributes, 3270-to-5250 keyboard re-mapping and workstation type negotiations.

AIX/6000
AIX for RISC System/6000 supports both the TELNET client and server functions.

The following options are supported:

- Binary Transmission (used in TELNET 3270 sessions)
- Suppress Go-Ahead (the RISC System/6000 system suppresses go-ahead)
- Timing Mark (recognized, but has a negative response)
- Extended Options List (recognized, but has a negative response)
- Echo (a user-changeable command)
- Term Type (allows the server to determine the terminal type used by the client)
- SAK (Secure Attention Key)
- NAWS (Negotiate About Window Size)

The telnetd server (also know as a daemon) is a subserver controlled by the inetd subsystem (also known as the super daemon).

The telnet command is identical to the tn and the TN3270 commands. It operates in two different modes:

- **Command Mode** - When the telnet command is issued without arguments, it enters the command mode. The user may enter telnet subcommands.

- **Input Mode** - When the telnet command is issued with arguments, it performs an open subcommand with those arguments and then enters input mode. The type of input mode is either character-at-a-time or line-by-line, depending on what the remote system supports.

The terminal-type negotiation will take place between the telnet command and the remote system when none of the following is used:

1. The -e command line flag
2. The emulate environment variable
3. The TN3270 command

The 3270, DEC VT100 and NONE (no emulation) terminal types are supported. In the case of 3270 emulation mode, keyboard remapping is supported.

The rlogin command and the rlogind server (daemon) can also be used if both the local and the target hosts are AIX (or UNIX) systems. The rlogin and rlogind programs are considered as not-trusted because the remote host does not require password authentication when one or both of the following conditions is satisfied:

1. The local host is included in the remote /etc/hosts.equiv file, the local user is not the root user, and the -l User flag is not specified.

2. The local host and user name is included in the $HOME/.rhosts file in the remote user account.

For security reasons, any $HOME/.rhosts file must be owned by either the remote user or root and should allow write access only by the owner.

Since rlogin and rlogind are considered as not-trusted, they can be disabled by running the securetcpip command. The securetcpip command is used to enable additional TCP/IP security environment by disabling commands that are not trusted. The telnet command and the ftpd daemon are considered as trusted command and daemon, respectively. For more details, please refer to AIX Version 3.2 for RISC System/6000 Communication Concepts and Procedures.

AIX/ESA
AIX/ESA supports both client and server TELNET functions.

The TELNET server supports the following options: binary, echo/no echo, suppress go ahead, timing mark and terminal type.

The client function is implemented by the telnet and TN3270 commands. It operates in two modes: command mode and input mode. The type of input mode used is either character-at-a-time or line-by-line.

If an HFT terminal is being used (the terminal supports the High-Function Terminal driver such as the PS/2 console), TELNET can emulate either a DEC VT100 terminal or an IBM 3270 terminal. The 3270

terminal types supported are: 3277-1, 3278-1, 3278-2, 3278-3, 3278-4 and 3278-5. If TELNET 3270 mode command is being used with a color display, then 3279 terminal type is supported.

In addition, the rlogin command can also be used to log into an AIX/ESA or AIX/ESA-compatible system, if your local system is listed in the /etc/hosts.equiv file on the remote system, or your system and your user name are listed in the .rhosts file in your home directory on the remote system.

Note: Any login operation is subject to the AIX/ESA security features in effect. For more details, please refer to AIX/ESA Security Features User's Guide.

OS/2

TCP/IP for OS/2 supports the following ASCII-based TELNET clients: TelnetPM, Telnet, Ansiterm, Telneto. The terminal types supported by these clients are VT220, VT100, ANSI, HFT and NVT. Supported 3270 terminal emulator TELNET clients are: PMANT, 3270 TELNET (PM) and TN3270. In addition, TN5250, which provides a PM-based 5250 emulation client, is supported.

- **VT220** - Uses emulation type VT220 to log on to a foreign host.

- **VT100** - Uses emulation type VT100 to log on to a foreign host. This implements a superset of VT100, since it supports all 12 function keys instead of just four.

- **ANSI** - Uses command Ansiterm to log on to a foreign host using ANSI mode, which is the native screen driver for an OS/2 command shell.

- **Telneto** - Uses command Telneto to log on to a foreign host using VT100 terminal emulation in true line mode. This is equivalent to VT200 in protocol support, and implements linemode capabilities as defined in RFC 1184.

- **PMANT** - Uses command PMANT to log on to a foreign host as a 3270 terminal. PMANT is an OS/2 Presentation Manager application which allows for keyboard remapping, VIO font selections, terminal screen size definitions (24x80, 32x80, 43x80, 27x132), extended colors support, extended highlighting support and OS/2 clipboard support.

- **3270 TELNET** - 3270 TELNET is a new client which is integrated in the OS/2 WorkPlace Shell. Apart from the improved GUI features, it provides similar functions to those of PMANT.

- **TN3270** - Use command TN3270 to log on to a foreign host as a 3270 terminal. TN3270 is a text application running under either an OS/2 window or full-screen session. It is similar to PMANT but does not include the Presentation Manager interface. TN3270 is recommended in lieu of PMANT when using TCP/IP for OS/2 over slower serial lines, such as SLIP. It supports keyboard remapping, alternative screen sizes and extended colors. Selectable fonts and copy to clipboard are also supported in an OS/2 window session. It only supports 80-column screens.

For any terminal type, a TELNET server must be running on the foreign host that supports that specific terminal type.

TCP/IP V2.0 for OS/2 can be a TELNET server, supporting VT220, VT100, ANSITERM or TN clients. Note that TELNET users that log into an OS/2 TELNET server have the capability of running any applications with the exception of OS/2 Presentation Manager (PM) applications.

DOS

TCP/IP for DOS provides three TELNET client implementations:

- DOS TELNET: To be used from the DOS command line.
- DOS TN3270: To be used from the DOS command line.
- Windows TELNET: To be used through the Windows interface.

TCP/IP for DOS does not provide a TELNET Server implementation.

The SETTERM command allows the configuration of a DOS TELNET client. This program is menu driven and allows the following settings:

- **Key assignment:** Specifies how keys are interpreted for the currently defined session. For example, PF8 can be assigned to the Down function.

- **Character translations:** Specifies how a particular character is translated. The decimal value (in the range of 0 to 255) for the byte to be translated must be entered. After this value is supplied, the system prompts for the replacement value (in the range of 0 to 255).

- **Video attributes:** Specifies foreground, background, and highlighting attributes.

- **Terminal choices:** Specifies the order of preference for terminals (five emulators are available) to use during a TELNET session.

- **Session hot-key definitions:** TELNET can open up to eight different sessions. You can assign a hot-key to each session. The session hot key is used to quickly switch among active sessions.

The modifications are stored in an ASCII file which can be referenced when the TELNET command is issued. It is possible to have different configuration files for different settings.

TELNET offers four terminal emulators:

- VT220
- VT100
- IBM-3278-2
- ANSITERM

Windows TELNET offers six terminal emulators:

- VT220
- VT100
- IBM-3278-2 through 3278-5
- ANSI
- TTY
- 5250

The terminal preference is generally handled through the SETTERM command but it can be specified with the TELNET command. All the TELNET sessions must be opened from a full-screen window.

TELNET provides a menu-driven interface that makes it easy to supply the information needed to begin a TELNET session.

When you TELNET to a remote host from a DOS workstation, at the same time you can initiate the TFTP server. Then from the remote host, you will be able to execute a TFTP session between that

host and the PC running DOS. When a file transfer request is detected, the TFTP Request menu is displayed. You can now decide the appropriate action to take (accept this transfer, deny this transfer, accept all future transfers, deny all future transfers). TELNET also allows you to temporarily go back to a DOS shell.

TELNET Server Client Cross Table

	TELNET function	
	Server	Client
VM	Yes	Yes
MVS	Yes	Yes
AIX/6000	Yes	Yes
AIX/ESA	Yes	Yes
DOS	No	Yes
OS/2	Yes	Yes
OS/400	Yes	Yes

Figure: TELNET Server and Client

3270 Full-Screen Cross Table

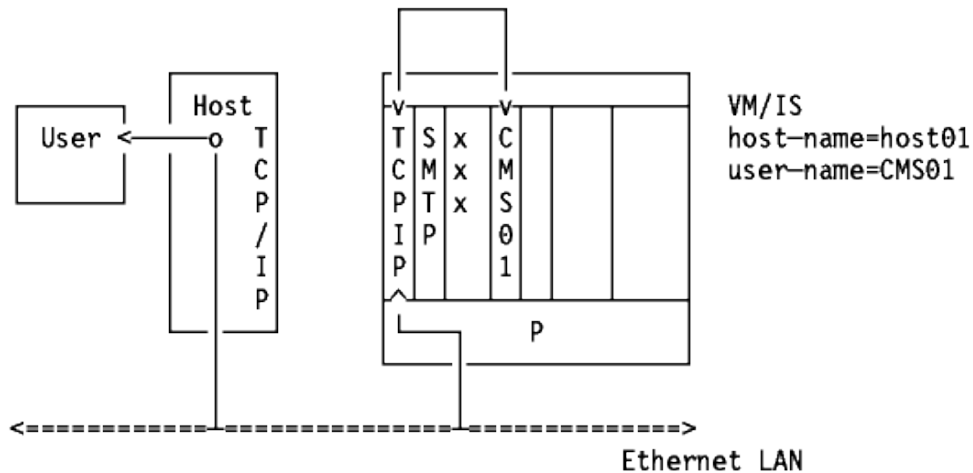|	Client	Server	Extended data stream
VM	Yes	Yes	Yes
MVS	Yes	Yes	Yes
AIX/6000	Yes	No	No
AIX/ESA	Yes	No	No
DOS	Yes	No	No
OS/2	Yes	No	Yes
OS/400	Yes	Yes	Yes(server)

Figure: 3270 Full-Screen Server and Client

TELNET Scenario
- User connected to host A needs to run a job on host B.
- Host A runs TCP/IP for IBM PC.

▪ Host B runs TCP/IP for VM.

```
                          ┌─────┐
                          │     │
        ┌───────┐  ┌──────┴─┐ ┌─┴───────────────────┐  VM/IS
        │ User ←│  │  Host  │ │-v      -v         │  host-name=host01
        │      ←│──│o   T   │ │ T │S│x│ C │ │ │ │  user-name=CMS01
        └───────┘  │    C   │ │ C │M│x│ M │ │ │ │
                   │    P   │ │ P │T│x│ S │ │ │ │
                   │    /   │ │ I │P│ │ 0 │ │ │ │
                   │    I   │ │ P │ │ │ 1 │ │ │ │
                   │    P   │ │ ^                 │
                   └───┬────┘ └─┬──────────────────┘
                       │        │       P
                       │        │
     <═══════════════════┴═══════════════════╧═══════════════>
                                                  Ethernet LAN
```

```
1) Login to          │     TELNET     host01
   remote host       │     LOGIN      cms01
                     v     PASSWORD   cmspw


2) Use the workstation as a local VM connected terminal.
   Using the standard VM procedures, you may for example:
        Dial, Note, Send file perform another remote login
   or run jobs under VM.

3) End of operation   │
                      v     QUIT
```

Figure: TELNET Scenario