NETLINK - A Network PAD Emulator

DATE:

TO:

FROM:

SUBJECT: NETLINK - A Network PAD Emulator

REFERENCE:

ABSTRACT

This document describes NETLINK, a program which allows a PRIMENET user to connect and login to a non-PRIME host on a Public Data Network. The ready acceptance and wide use of this program throughout PRIME indicates that it would be a valuable enhancement to our current network offering.
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INTRODUCTION

As more vendors allow access to their systems from Public Data Networks, PRIMINET users will become more aware of a serious lack in our ITS (Interactive Terminal Service) offering. From a public network PAD, the user can login to any host on the network. With PRIMINET, however, the user can only log into other PRIMINET systems on the network. If the user has a need to access services that are not offered on PRIME equipment, he must resort to the aggravation and unnecessary expense of using a PAD. Therefore, a useful enhancement to the PRIMINET X.25 product, would be support for remote login to non-PRIMINET systems.

NETLINK is an external program that implements this functionality. It uses PRIMINET's IPCF (Inter-Process Communications Facility) to emulate a Public Data Network PAD. Using this program a PRIME user can establish a connection and log in to any system on the Public Data Network. This functionality increases a user's visibility of available systems from a dozen or so PRIME systems to hundreds of computers, comprised of almost every vendor's equipment. A user who has arranged for the appropriate accounts could sit at his terminal and login to systems that supplied bibliographic data, data on licensed technology, data on Canadian law, or up-to-the-minute data on stocks, bonds, and future prices. PRIMINET's implementation of the X.25 standard dramatically expanded our network capability across geographic boundaries. NETLINK (implementing the X.3 and X.29 standards) builds on X.25 to expand one of our network capabilities across vendor boundaries.

The remainder of this document describes a version of this program installed as the experimental command NETLINK. Questions, comments, and remarks will be greatly appreciated. X-mail them to D.JABS, or call 879-2950 x4126.
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2. AN EXAMPLE

The basic steps to use NETLINK are as follows:

1) Invoke NETLINK.
   NETLINK will enter Command Mode and prompt for a command with an 'Ø'.

2) Enter the command, 'C <address>'
   <address> is either the host address assigned by the Public Data Network, or a PRIMENET system name (e.g., 617 74 or NODE1)

3) NETLINK will respond with '<address> Connected'
   This indicates that NETLINK has completed the establishment of a call (connection) to the remote computer. You may now begin a terminal session just as if your terminal were connected to the remote computer locally.

4) When you're finished, logout normally.
   After you have logged out, NETLINK prints '<address> Disconnected' to indicate that the connection to the remote host has been terminated. NETLINK will return to Command Mode and prompt you with an 'Ø'. At this time you may either make another call (goto step 2) or return to PRIMOS. To return to PRIMOS, type 'QUIT'.

Below is an example of using this procedure to login to PRIMOS. User input is underlined.
OK, NETLINK
[NETLINK version 1.0]

? C_NODE1
NODE1 Connected

PRIMOS 17.1 NODE1
LOGIN ECO

PRIMOS Version 17.1
FOO (ECO) LOGGED IN AT 11:43 091376

Enter validation code: BAR

OK.

Continue with normal terminal session.

OK.

FOO (ECO) LOGGED OUT AT 11:44 091379
TIME USED= 0:01 0:00 0:01

WAIT...

NODE1 Disconnected

QUIT

OK.
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3. ELEMENTARY_NETLINK

3.1 BASIC COMMANDS

HELP - Provide help.
This command will print the syntax and brief annotation of the basic commands. NETLINK will then ask the question "Advanced features?". Answers of 'YES' or 'OK' will cause NETLINK to print the syntax of the extended features and advanced commands.

QUIT, Q - Exit to PRIMOS command level.
This command returns the user to PRIMOS. It will clear all currently active circuits.

PAUSE, PA - Exit to PRIMOS but allow return
This command returns the user to PRIMOS without altering his state. A subsequent 'S' command will return you to command mode in NETLINK. This enables one to use PRIMOS internal commands without affecting the state of an NETLINK circuit.

C <address> - Connect to an address and port.
Initiates a connection to the specified address, as an X.25 character mode PAD. The following address forms are currently accepted:

<name>: A PRIMENET style system name
(EX.) ENP
(MPK T.R

<1 - 14 digits>: '0' escape for full address with DNIC
(EX.) 031106170007400
012345
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where N represents a digit and A a character. Spaces are optional and ignored. Each address is expanded according to TELNET style addressing rules with the default DNIC as the first 4 digits. A subaddress (two more digits) may be specified by appending 'NN'.

(EX.)  617 74 or 61774
       213 123 or 401 1234
       617MB
       6030 0020 or 603 000 20 etc.
       202 35.01, 617MB.10 or 10000020.99

NETLINK will respond with one of several messages indicating errors or the state of the call. Additional errors may also be found in the section on clearing messages.

<address> Connected
NETLINK has successfully connected to the remote host.
Follow normal login procedures.

<address> Still Connected
NETLINK is still connected to this address. If you wish to continue your sessions use the 'CONTINUE' command. If you wish to connect to another address, you must first disconnect with the 'D' command.

<address> Still Pending
A call request is still pending to the remote host. If you wish to connect to another address, you must first disconnect with the 'D' command.

<address> Not Obtainable  Line Down
There is no path available to the remote host. The normally available path is down. Contact your computer center staff to find out when service will be resumed.

<address> Not Obtainable  Illegal Address
The system can not find a route to the remote system. Verify that you have the correct address, and that your system has the correct network connections.

<address> Rejecting
The remote host has rejected the call request by clearing the circuit. Additional information may be supplied. See the description of the 'Disconnected' message in the section on Clearing Messages.
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Illegal address format "<text>"

The address you supplied was not one of the allowed formats. Either you can't type or you can't read!

Connect error: <m> <n>

This indicates an unanticipated error in the call to IPCF routine XLCONN. <m> and <n> are the decimal values of the circuit state vector. Refer to the definition of circuit status values in the file XIKEYS to interpret their meaning.

NC <address> - Connect without Reverse Charging

Same as the connect command except that Reverse charging is not requested.

CONTINUE, CONTINS, CO - Continue a currently active circuit.

This command is used to return to a circuit which has been exited via the 'escape to command mode' escape sequence (CR & CR). NETLINK echoes a line feed to indicate that you are reconnected.

D, CLEAR - Disconnect (Clear) the currently active circuit.

This command clears the current circuit. It is used when either because of network or host problems one is unable to log out of the remote host. NETLINK will respond with the 'Disconnected' message to indicate that the circuit has been cleared.
3.2 BASIC FEATURES WHILE CONNECTED

1) NETLINK does not distinguish between <cuits> and <breaks>. Both end up as a <break> simulated to the remote host.

2) NETLINK recognizes certain escape sequences.

   'ESCAPE <break>* puts a Control 'P (octal 20) into the input data stream.

   'CR & CR' is the escape to command mode sequence. The first CR is put into the data stream and forwarded to the remote host.
   NETLINK then exits to command mode and discards the 'CR'.
   Another way of thinking of this escape sequence is 'CR' at the beginning of a line. If the sequence contains more than 1 'CR' then NETLINK will not exit to command mode and will forward a line containing 1 less 'CR'.

3) NETLINK keeps the terminal characteristics of the circuit distinct from the terminal characteristics at 'command mode'. Therefore a user has his remote terminal characteristics only when he is attached to the circuit. In command mode a user has the terminal characteristics he had when he ran NETLINK. These characteristics include editing characters, XOFF, duplex and line feed insertion.

4) NETLINK supports line editing for those hosts which request it. The following editing characters are recognized as the default, but the host may reset them to be others more congenial to its user interface.

   Control 'X (CAN) - Delete current line
   NETLINK deletes the current line and echoes 'DELETED'.

   DEL or RUBOUT - Delete one character
   NETLINK deletes the last character and echoes '\<character>'

   Control 'P (DC2) - Retype current line
   NETLINK echoes the current line and leaves the type ball (cursor) at the next character position on the line.
4.1 Command Mode Messages

NETLINK has 5 general messages that are commonly received in command mode. Other messages are specific to a command and are explained with the command description.

? NETLINK is prompting you for the next command.

? The command or command line was incomprehensible.

Not Connected
The command expected you to be associated with an active circuit and you weren't.

Illegal argument "<text>"
The <text> is not a valid argument to the command. Normally this results from giving a number of the wrong type or magnitude, or a keyword out of place, or text where a number (or vice versa) was expected.

Format Error
The command was recognizable, but the rest of the syntax wasn't. Verify that you understand what you are doing before proceeding.
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4.2 Messages While Connected

NETLINK may print several error messages during the course of the connection indicating problems with the virtual circuit or communications path. All error messages start with '***' for easy identification.

***X.25 RESET - POSSIBLE DATA LOSS***
Due to problems with the network a data packet to or from you may have been lost.

***WAIT TIMEOUT***
***BUFFER TIMEOUT***
A buffer that should have been acknowledged has not been acknowledged for 30 seconds. This is usually caused by network problems resulting in a loss of acknowledgement information. NETLINK will attempt to reuse the buffer. Usually this results in further error messages (see below) and finally requires one to clear the circuit.

***REMOTE NODE NOT ACKNOWLEDGING - DATA DISCARDED***
Due to buffer timeouts too many requests for transmission have been generated. The current buffer is discarded. You should escape to command mode and disconnect the circuit.

***INTERRUPT <n>***
The remote host has sent an interrupt packet. <n> is the interrupt data byte in octal. This is a protocol error which can be ignored. It is most often encountered when you are connected to a host which uses the obsolete TELENET protocol.

***XMIT ERROR: <n>***
***RCV ERROR: <n>***
An unexpected error code has been returned from a network transmit or receive call. <n> is the value of the status word in error. To interpret the value one must refer to the definition of error returns in the X3KEYS file. This normally indicates a problem with the PRIMENET software or NETLINK itself.
4.3 CLEARING MESSAGES

Whenever a connection is terminated (cleared), NETLINK prints a message indicating the reason for the clear. These messages are described below.

<address> Disconnected
Your connection has been cleared by the remote host. This message normally occurs when you have logged out, or disconnected the circuit with the 'D' command. If it appears at other times, then it indicates problems with the network.

<address> Disconnected nnnnn ( <message> )
Your connection has been cleared by the remote host with a non-zero diagnostic byte. 'nnnnnn' is the octal value of the diagnostic byte. If present, '( <message> )' is the PRIMENET interpretation of the diagnostic byte. Note that this interpretation is only valid if the remote host is running PRIMENET software.

<address> Disconnected mmmmm nnnnnn
Your circuit has been cleared with a non-standard clearing cause and clearing diagnostic. 'mmmmmm' and 'nnnnnn' are the octal value of these bytes respectively.

<address> Busy
All available ports to this host are currently in use. Try again later.

<address> Invalid Call
There is an error in the call request packet.

<address> Network Congestion
Temporary network problems. Try again later. If the problem persists, contact your computer center staff. (This error indicates problems with the Public Data Network)

<address> Not Obtainable
There is no path available to the remote host.

<address> Out of Order
The remote host is currently not available to network users. Check with the computer center staff to find out when service will be resumed.

<address> Access Barred
Access is not allowed from your address.
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<address> Refusing Call
You can not make collect calls to this host. Use the 'NC' command.

<address> Remote Procedure Error
<address> Local Procedure Error
A network protocol error has been encountered. Try again. If the problem persists, notify your computer center staff.
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5. ADVANCED FEATURES OF NETLINK

5.1 EXTENDED OPTIONS FOR THE 'IC' COMMAND

NETLINK supports options that allow a user to completely specify the various fields of the connect packet. This is occasionally required by the perverse implementation of a host's or international gateway's software.

-PORT <n>

This option specifies a PRIMENET style 'port' to connect to. This is required when the destination of your connection is a program on PRIMOS, rather than the ITS (Interactive Terminal Service). The port number is passed in the protocol ID field of the connection request. Therefore this option is incompatible with the -PRID option (see below).

-FCTY <byte1> <byte2> ... <byte-n>

This option allows a user to specify a non-default facilities field. <byte1> ... <byte-n> are up to 32 bytes (specified in octal) to be laid into the facilities field. They replace the default facilities of '001 001 002 007' (Reverse charging, Throughput class 7). A '-FCTY' option without arguments is supported and results in a 0 length facilities field.

Too many facilities
You have specified more than 32 bytes of facilities information. Remove some of your facilities.

-DATA <text>
-MDATA <text>

These two directives specify up to 12 characters of text to be put into the User Data Field. -DATA inserts the characters with parity bits stripped, while -MDATA inserts the characters as received from PRIMOS (i.e. with parity marked). Currently the -DATA option is used to specify a TELENET address to the DATAPAC to TELENET gateway.
-PRID <byte1> <byte2> <byte3> <byte4>
-PRID "<text>"

The protocol ID field must consist of 4 bytes. The four bytes may be specified either in octal, or as a quoted string of 4 characters. Note that characters are inserted into the protocol ID field with stripped parity. This is useful when it is necessary to treat the protocol ID field and user data field combined as a 16-byte user data field. The data replaces the default Protocol ID field which is '001 000 000 000' (X.25 character mode PAD, unknown terminal type). This option can not be used in conjunction with the '-PORT' option, since '-PORT' uses this field to pass the port number. In addition, a '-PRID' option with no arguments resets the Protocol ID field to be available for PRIMENFT's use.

Protocol ID field must be 4 bytes
You have specified an incorrect number of bytes. You must specify either none or 4 bytes of protocol ID information.
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5.2 CIRCUIT STATUS COMMANDS

STATUS

This command prints the status of any currently active circuits, or "No Active Circuits" if there are none. The information printed includes the circuit number and arrow (used only in multiple III mode see below), the address connected to, the time the circuit has been open (in hours and minutes), and the packets received and transmitted. An example follows:

<table>
<thead>
<tr>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit #</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>-</td>
</tr>
</tbody>
</table>

5.3 III PARAMETERS

These commands are only valid after a connection has been established. To use these commands, you must use the escape to command mode sequence (CR CR).

SET <parameter>:<value> <parameter>:<value> ...

This command allows a user to set his level 1 parameters. Level 1 parameters are the means by which terminal characteristics (i.e. Data Forwarding, Timers, Special characters, Duplex etc.) are controlled. <parameters> and <values> are specified in decimal. The user should refer to documentation of the level 1 parameters for the applicable network for a description of the meaning of specific parameters and the allowed values. Currently NETLINK supports subsets of the international parameters, DATAPAC parameters and TELENET parameters (See Appendix for a complete list). DATAPAC and TELENET parameters must be preceded by the National Options Marker (NOM). The NOM for TELENET is '0:33' and for DATAPAC is '0:10'.

The following errors are not fatal. If these are the only errors encountered then all other parameters have been processed. If any other error occurs, then only those parameters up to the parameter in error are processed.
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Illegal parameter: <parameter>:<value>
The specified parameter is not supported. Make sure that you have specified the correct parameter.

Illegal value: <parameter>:<value>
The specified value is illegal or unsupported. Verify that the value specified is correct before blaming the programmer.

PAR <parameter> <parameter> ...

This command allows a user to read his current level 1 parameters. The <parameters> are specified in decimal. NETLINK will print the values in the following format:

<parameter>:<value> <parameter>:<value> ...

Both <parameters> and <values> are printed in decimal. An unsupported <parameter> will have the text 'INV' in the <value> field.

A request to read National parameters must have the NOM preceding the parameters. Thus a PAR command to read international parameters 3 and 4, and TELNET parameter 18 would be:

@PAR 3 4 0:33 18

Too many parameters
This error message indicates that the PAR command requests more data than will fit into NETLINK's internal buffer. Break your request up into two PAR commands with fewer parameters to each one.

PAR

A 'PAR' command with no arguments is special-cased. NETLINK will print a readable representation of the supported international parameters and TELNET's NVT options parameter. Parameters which are disabled are not printed. This command is a network equivalent of a 'TERM -DISPLAY' command to PRIMOS.

(Ex.)

@ PAR

FULL DUPLEX
FORWARD DATA ON: OR ESC Terminators Other Ctrl
IDLE TIMER = 1.0 Secs.
ON BREAK: Interrupt Send indication of break Discard output
X-OFF/X-ON ENABLED
NETWORK VIRTUAL TERMINAL FEATURES: Process Control
FILE MANIPULATION

These commands are only valid after a connection has been established. To use these commands, you must use the escape to command mode sequence ("CR \& CR").

FILE <filename> <option list>

This command specifies that input data should be sucked from a PRIMOS edit format (i.e., compressed) file, instead of the user's terminal. If no options are given, then the characters from the file are read in, reformatted into full network packets, and forwarded to the remote host as input. Normally, the destination is an editor (in INPUT mode) on the remote machine. A typical scenario is to connect and login to the remote host as usual. Next, a user would enter the editor on the remote host. When the editor is ready for input from the terminal the user should escape to command mode in NETLINK (via "CR \& CR"). The FILE command tells NETLINK to get data from the specified file and forward them to the remote host. A 'CONTINUE' command will return you to the circuit and NETLINK will commence sending the file. While the file is being sent, the data is not echoed to the user's terminal. When the file has been completely forwarded, NETLINK will ring the bell and print the message 'End of file. <name>'. The user is returned to the normal state where input is expected from the terminal. Typically he would type what is necessary to exit from the editor and save the file.
An example with PRIMOS follows. User input is underlined.

```
@ C_NODE1
NODE1 Connected
PRIMENET 17.1 NODE1
LOGIN ECO
ECO LOGGED IN AT ...
...
OK, ED
INPUT
E

@ FILE_ECO>BAR
@ CONTINUE
```

End of file. BAR
<carriage_return>
EDIT
FILE_JUNK

OK.

While the file is being sent, all data from the terminal is discarded with the following exceptions:

1) A <break> will send a break sequence to the remote host and terminate sending the file.

2) The \"escape to command mode\" sequence ('CR @ CR') will return the user to command mode without affecting the state of the file or the data being sent.

Command line options are provided to modify the forwarding characteristics of the data stream to the remote host so that a user can overcome limitations and assumptions made by the remote host's software. The following options are currently supported.

-TRANS Send file transparently

This option specifies that the file is to be forwarded to the remote host without any reformatting or parity stripping. This mode has limited usefulness.

-TTYON Echo to the terminal data being sent
This option permits the user to see the data being sent to the remote host. It has the drawback that data forwarding speed is limited to the speed of the user's terminal.

-LINE Send packets on end of line instead of full packet

Some X.25 hosts, in their implementation of ITU make the assumption that each packet received from a PAD is exactly one line of text. As a consequence, filling the packets will result in improper reassembly of the data at the remote host. This option will forward data consistent with the 'line at a time' assumption. The disadvantage is that it is much slower and uses more packets than sending full packets.

-PAI Insert a space on null lines

Many editors interpret a null line as a command to switch state from 'EDIT' to 'INPUT' mode, or vice-versa. This option directs NETLINK to insert a space as the first (and only) character on a null line to overcome this difficulty.

-CES <n> Limit data rate to <n> characters per second

This option specifies that NETLINK should delay the forwarding of the next packet until sufficient time has elapsed so that the average data rate will not exceed <n> characters per second. Normally, this option is used in conjunction with the -LINE option to overcome front end X.25 'black boxes' which do not properly flow control the PAD. Consequently too high a data rate results in the remote host losing characters. This problem may be due either to host assumptions about how fast a user can type or problems with the code in the X.25 'black box'.

OUTFILE <filename> <options list>

This command specifies that input and output data should be written to a file. This functionality is similar to the PRIMOS 'CCMG' facility, except that it provides some extra functionality unique to networks, and that only data sent or received on the circuit are written to the file. Commands to NETLINK or PRIMOS are not written to the file.

Like the 'FILE' command, a <break> will terminate an OUTFILE. Caution should be used, as this means of terminating an output file may result in lost characters. The escape to command mode sequence is handled exactly as in the 'FILE' command.
There are two means by which an output file may be terminated. The first is to explicitly close the file with the 'CLOSE OUTFILE' command. Optionally, the file may be closed whenever no data has been received for a specified timeout period. This timeout option is not enabled in the default case.

Command line options:

-TIMEOUT <n> Terminate file after timeout

This option specifies that the output file should be closed after <n> seconds without any received data. For convenience, the timer does not start running until the first data packet has been received. When the timer runs out, the message 'End of outfile, <name>' will be logged to the terminal and the file will be closed. A timeout value of 0 is equivalent to disabling the timeout feature.

-NTTY Do not print output to terminal

This option specifies that output data should not be printed at your terminal. Input data will still be echoed as normally. In addition, if the '-TIMEOUT' option is not specified, a default timeout value of 30 seconds will be assumed.

-CONTIN Append to output file

This option causes NETLINK to append the data to the end of the specified file, instead of overwriting.

CLOSE {FILE | OUTFILE}

This command specifies that a currently active file (from the FILE or OUTFILE command, as appropriate) should be closed. This command is useful to terminate the sending of a file from the FILE command before it is completed, or if something has gone wrong. 'CLOSE OUTFILE' is used to terminate the writing of data to an output file.

FILE AND OUTFILE ERROR MESSAGES

File still open <name>

You have a previous file of the same type (input or output) already open. Use the 'CLOSE' command to close the previous file.
No file name
Your first argument after the FILE or OUTFILE command must be a filename. This error message indicates that this was not the case. Retry the command, but type the right thing this time!

<File system error> <name>
NETLINK encountered a standard file system error on a file system call.
3.5 MODIFYING NETLINK'S PROGRAM PARAMETERS

The following commands affect the parameters of the NETLINK program itself. The action of a command affects the currently active circuit and all future connections established in the same session.

PROMPT <text>

This command allows the user to change the NETLINK command mode prompt. The <text> must be 0 to 3 characters in length. The <text> (plus a trailing space) replaces the current prompt. This is particularly useful when one has used NETLINK to log into a remote machine and is running a program with the same prompt as NETLINK. Changing X.ITU's prompt greatly reduces the confusion when exiting to command mode.

POLL <n>

This command allows a user to set the time interval at which the terminal buffer will be polled. <n> specifies the tenth's of a second between successive checks of the user's terminal buffer for characters to send to the remote host. The default value for <n> is 5, or a polling rate of twice a second.

*ITU [ON | OFF]

This command sets the multiple ITI switch. If no argument is given then 'ON' is assumed. The multiple ITI switch enables or disables the use of many concurrent ITI connections (see description of multiple ITI below).

DEBUG [ON | OFF]

This command sets the debug switch. If no argument is given then 'ON' is assumed. The debug switch enables the printing of messages on transmits and receives, as well as other events to aid in the identification of bugs or network problems. (See description of Debug messages below.)

*TIMEOUT <n>

This command allows a user to change the default value for buffer timeouts. <n> is the timeout time in seconds. NETLINK double buffers input to go to the remote host. At times, when the network or remote host is not operating properly, acknowledgements of these buffers may be lost in the network. When this happens NETLINK may not have a buffer for data from the terminal. This results in the user being 'hung'. To prevent the user from being permanently trapped, NETLINK 'times out' on this condition after the specified time and logs '***BUFFER TIMEOUT***' to inform the user of the fact. NETLINK will then utilize the buffer to accept terminal input so that the user may escape to command mode and disconnect the circuit.
Currently the default timeout is 30 seconds. At the current time the longest 'justifiable' network delay we have seen is about 15 seconds, but this doesn't necessarily mean we will not ever see longer times.

**DNIC <text>**

This command allows a user to specify the default Data Network Identification Code for address parsing purposes. NETLINK supports 5 and 6 digit shorthand formats for specifying the last 5 digits of a network address. This command allows a user to control the first 4 digits NETLINK should use. The <text> must be either null or four digits. A null text indicates that no DNIC should be inserted at the beginning of the address. Otherwise the specified four digits are inserted as the DNIC of the address. The default DNIC in NETLINK is '3110' (TELENET).

**FCTY <byte1> <byte2> ... <byte-n>**

This command allows one to change the default facilities field used for all connections. The values replace the normal facilities field of 1 1 2 7 (Reverse charging, Throughput class 7). Note: For the 'NC' command to work, the Reverse charging facility must be first. In that case, the action of the 'NC' command is to reset the Least significant bit of the parameter's value. Arguments and errors are the same as for the '-FCTY' option to the 'C' command.

**PRID <byte1> <byte2> <byte3> <byte4>**

This command allows one to change the default protocol ID field used in all connections. The values replace the normal protocol ID field of 1 0 0 0 (X.29 character mode PAD, unknown terminal type). Arguments and errors are the same as for the '-PRID' option to the 'C' command.

These last 3 commands are intended to be used to tailor NETLINK to the variations encountered in different Public Data Networks. The 'normal' defaults are selected to work in TELENET. For other PDN's the following commands should be used:

**PSS (UK)**
DNIC 2341

**DATAPAC (Canada)**
DNIC FCTY 1 3
The global nature of the NETLINK modifiers allows a version of X.ITI to be permanently tailored with respect to these commands by the following procedure:

OK, RESTORE_NETLINK
OK, E
SA,CA,F,APA,Y,K=
<sa> <ea> 1000 0 0 0 0

PF,SH,LF,YB:
+1000/1000 0/0 4000/*xxx 0/0
SAVE_JUNK_1520 <ea>
OK, S
<commands>
.
.
.
.
PAUSE
OK, REST_JUNK
OK, SAVE_NETLINK <sa> <ea> 1000 0 0 0 0
OK, DELETE_JUNK
OK.
NETLINK supports the ability to have up to 4 concurrent ITI circuits open and to switch back and forth between circuits. Multiple ITI mode is entered by enabling the multiple ITI switch (via the MITI command). In this mode the meanings of the basic commands are extended, and a new command 'SW' is enabled. Switching is always accomplished by first escaping to command mode, and then initiating or continuing a different circuit. Note that while a circuit is not attached to, no activity happens on that circuit and it's state is preserved unaltered until it is 'CONTINUED'.

C or NC

This command no longer will give an error message if there is already an active circuit. Instead, a connection is initiated to the new address and assigned a circuit number from 1 to 4. This number is printed to the terminal when the connection is initiated. The number is used as the unique identifier of the circuit for the other commands.

No Free Circuits

This error indicates that the maximum number (4) of circuits are in use already. This connection cannot be established until one of the other circuits is disconnected.

CONTINUE <n>

The CONTINUE command optionally takes a circuit number to indicate which circuit to re-attach to. If no number is given then the most recently referenced circuit is used. This current circuit is identified by the '->:' in a STATUS command.

) <n>
) ALL

An optional argument of a circuit number clears the referenced circuit. If no circuit number is supplied then the current circuit is cleared. The argument 'ALL' causes NETLINK to clear all the currently active circuits, and log a 'Disconnected' message for each one.

SW <n>

This command switches the current 'default' circuit to the circuit referenced by the circuit number. The user is left in command mode so that he may use commands such as PAR, SET, and FILE.
CIRCUIT does not exist
This message indicates that the referenced circuit is not valid. Your current circuit remains unchanged. You may either CONTINUE your current circuit, or retry the command, specifying a correct circuit number.
APPENDIX A - DEBUG MESSAGES

These messages are only printed when the debug switch is enabled. They identify major events in the operation of NETLINK. Each message is preceded by a '***' for easy identification. Unless otherwise specified, all numeric values are printed in decimal.

***RCV <m> TYPE <n> BYTES <o> INTERVAL <p> RESPONSE
This message indicates that a receive has been completed. <m> is the 'level' data that was received (0 or 1). <n> is the number of bytes received. <o> is the interval of time since the last receive, and <p> is the interval of time since the last transmit. Both <o> and <p> are in 1/20'ths of a second.

***TRAN <n> BYTES <o> IDLE <p> INTERVAL
This message indicates that a transmit has been initiated. <n> is the number of bytes. <o> is the interval since the last character was gotten by the program, and <p> is the interval since the last transmit. Both <o> and <p> are in 1/20'ths of a second.

***LEVEL 1 <t>
<p1> <v1>
<p2> <v2>
etc.
This message logs the data in a level 1 packet and the results of NETLINK's attempt to parse that data. <t> is the level 1 type field. <p1>, <v1> are parameter, value pairs. If a pair is followed by an 'X' that indicates that the parameter is unknown. If the pair is followed by a '*' then that indicates an illegal or unsupported value. This message is particularly helpful in determining why terminal characteristics are being screwed up.

***BREAK <m> <n>
This message indicates that <break> processing has commenced. <m> is the octal value of the break handling flags. <n> is the count of <break> left to handle (including this one).

***ASSURED
This message occurs after a '***BREAK' message to indicate that an 'ESC <break>' has been parsed, and therefore a control P is being forwarded.
APPENDIX B - I II I PARAMETERS

Below is included a complete list of the level 1 parameters supported by NETLINK. The subset of parameters to support was chosen with the following criteria: only those parameters which are necessary for the proper assembly and forwarding of data to/from the remote host are supported. Parameters which apply to (break) protocols, or data forwarding, insertion, and editing must be supported. Functionality which applies to output format (line folding), or terminal hardware characteristics (newline padding, Echo masks) are extraneous, and are better dealt with at the PRIMOS or hardware level. Parameters which control the user's access to NETLINK functionality (command mask) are intentionally ignored, as the ability to use NETLINK commands should not be restricted.

INTERNATIONAL PARAMETERS

0 - National Options Marker (only values of 0 and 33 supported)
2 - Echo
3 - Data Forwarding
4 - Idle Timer
7 - Break Handling
8 - Discard Output
12 - DTE to DCE Flow Control

TELNET PARAMETERS

1 - Line Feed Insertion
3 - Echo (same as international parameter 2)
5 - Data Forwarding (same as international parameter 3)
17 - Break Code
18 - NVT Options
27 - Delete Character
28 - Cancel Character
29 - Display Character
30 - Abort Output Character
34 - Transmit on Timers (only a value of 0 supported)
35 - Idle Timer
36 - Interval Timer
40 - Insert on Break
45 - Send ACK on Break
54 - DTE to DCE Flow Control (same as international parameter 12)
57 - Connect Mode (only a value of 2 (Virtual) supported)
59 - Flush Output on Break

DATAPAC PARAMETERS

126 - Line Feed Insertion (same as TELNET parameter 1)