

TN3270 Enhancements

Status of this Memo

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Abstract

This document describes a protocol that more fully supports 3270 devices than do traditional tn3270 practices. Specifically, it defines a method of emulating both the terminal and printer members of the 3270 family of devices via Telnet; it provides for the ability of a Telnet client to request that it be assigned a specific device-name (also referred to as "LU name" or "network name"); finally, it adds support for a variety of functions such as the ATTN key, the SYSREQ key, and SNA response handling.

This protocol is negotiated under the TN3270E Telnet Option, and is unrelated to the Telnet 3270 Regime Option as defined in RFC 1041 [1].

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1. Introduction

Traditionally, support for 3270 terminal emulation over Telnet has been accomplished by the de facto standard of negotiating three separate Telnet Options - Terminal-Type [2], Binary Transmission [3], and End of Record [4]. Note that there is no RFC that specifies this negotiation as a standard. RFC 1041 attempted to standardize the method of negotiating 3270 terminal support by defining the 3270 Regime Telnet Option. Very few developers and vendors ever implemented RFC 1041.

This document will refer to the existing practice of negotiating these three Telnet Options before exchanging the 3270 data stream as "traditional tn3270". Traditional tn3270 is documented in [10].

NOTE: Except where otherwise stated, this document does not distinguish between Telnet servers that represent SNA devices and those that represent non-SNA 3270 devices.

All references in this document to the 3270 data stream, 3270 data stream commands, orders, structured fields and the like rely on [5].

References to SNA Request and Response Units rely on [6]. References to SNA versus non-SNA operation rely on [7].

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

There were several shortcomings in traditional tn3270; among them were the following:

- It provided no capability for Telnet clients to emulate the 328x class of printers.
- There was no mechanism by which a Telnet client could request that a connection be associated with a given 3270 device-name. This can be of importance when a terminal session is being established, since many host applications behave differently depending on the network name of the terminal. In the case of printer emulation, this capability is an absolute necessity because a large number of host applications have some method of pre-defining printer destinations.
- The 3270 ATTN and SYSREQ keys were not universally supported.
- There was no support for the SNA positive/negative response process. This is particularly important if printer emulation is to function properly, but is also useful for some terminal applications. A positive response is used to indicate that the previously received data has been successfully processed. A negative response indicates some sort of error has occurred while processing the previously received data; this could be caused by the host application building a 3270 data stream that contains an invalid command, or by a mechanical error at the client side, among other things.

- There was no mechanism by which the client could access the SNA Bind information. The Bind image contains a detailed description of the session between the Telnet server and the host application.
- There was no mechanism by which the server could determine whether a client supported 3270 structured fields, or a client could request that it receive them.

1.1 Changes to RFC 1647

This document replaces RFC 1647; the following is a summary of the changes that have been incorporated:

- Reworded the Introduction to refer to traditional tn3270 in the past tense.

Affected sections: 1.

- Added this section documenting changes to RFC 1647

Affected sections: 1.1

- Clarified the specification of numeric literals contained in the document.

Affected sections: 3. (first paragraph)

- Extensively revised several sections to

- 1) clarify the motivation behind and use of the ASSOCIATE command
- 2) remove restrictive wording regarding the organization and use of server maintained device pools
- 3) distinguish between device-names and resource-names in the TN3270E device-type negotiation, and define a maximum length for device-names and resource-names

Affected sections: 4. (DEVICE-TYPE REQUEST command) and 7.1.1 through 7.1.6

- Corrected the erroneous specification of the format of the function-list sent during TN3270E functions negotiation.

Affected sections: 7.2.1 (first paragraph)

- Added a statement addressing what a client or server should do if an impasse is reached during TN3270E functions negotiation.

Affected sections: 7.2.1 (last paragraph)

- Added a DATA-TYPE of PRINT-EOJ with a value of 0x08 to support the end-of-job indication for printers.

Affected sections: 8.1.1, 10.1, 10.2

- Clarified the description of the SEQ-NUMBER Field to state that
 - 1) the field should be sent in network byte order (big endian)
 - 2) either byte that contains a 0xff must be doubled to 0xffff before sending, and stripped back to 0xff after receipt.

Affected sections: 8.1.4

- Defined the format and maximum length of the Bind image.

Affected sections: 10.3 (fourth paragraph)

- Clarified the misleading wording regarding allowable DATA-TYPES when BIND-IMAGE has been negotiated and a BIND has been sent.

Affected sections: 10.3 (last paragraph)

- Clarified the use of the SEQ-NUMBER field in regards to when it should be reset to zero.

Affected sections: 10.4 (last paragraph)

- Clarified the format of the data when the DATA-TYPE field is SSCP-LU-DATA.

Affected sections: 10.5.2 (fourth paragraph)

- Reworded the Security section to refer to Kerberos.

Affected sections: 14.

2. TN3270E Overview

In order to address these issues, this document proposes a new Telnet Option - TN3270E. Telnet clients and servers would be free to negotiate support of the TN3270E option or not. If either side does not support TN3270E, traditional tn3270 can be used; otherwise, a sub-negotiation will occur to determine what subset of TN3270E will

be used on the session. It is anticipated that a client or server capable of both types of 3270 emulation would attempt to negotiate TN3270E first, and only negotiate traditional tn3270 if the other side refuses TN3270E.

Once a client and server have agreed to use TN3270E, negotiation of the TN3270E suboptions can begin. The two major elements of TN3270E sub-negotiation are:

- a device-type negotiation that is similar to, but somewhat more complicated than, the existing Telnet Terminal-Type Option.
- the negotiation of a set of supported 3270 functions, such as printer data stream type (3270 data stream or SNA Character Stream), positive/negative response exchanges, device status information, and the passing of BIND information from server to client.

Successful negotiation of these two suboptions signals the beginning of 3270 data stream transmission. In order to support several of the new functions in TN3270E, each data message must be prefixed by a header. This header will contain flags and indicators that convey such things as positive and negative responses and what type of data follows the header (for example, 3270 data stream, SNA Character Stream, or device status information).

3. Command Names and Codes

Please note that all numeric literals in this document specify decimal values, unless they are preceded by "0x", in which case a hexadecimal value is represented.

TN3270E	40
ASSOCIATE	00
CONNECT	01
DEVICE-TYPE	02
FUNCTIONS	03
IS	04
REASON	05
REJECT	06
REQUEST	07
SEND	08

Reason-codes	
CONN-PARTNER	00
DEVICE-IN-USE	01
INV-ASSOCIATE	02
INV-NAME	03

INV-DEVICE-TYPE	04
TYPE-NAME-ERROR	05
UNKNOWN-ERROR	06
UNSUPPORTED-REQ	07

Function Names	
BIND-IMAGE	00
DATA-STREAM-CTL	01
RESPONSES	02
SCS-CTL-CODES	03
SYSREQ	04

4. Command Meanings

Refer to the Telnet Protocol Specification [8] for the meaning of IAC, DO, WILL, etc.

IAC WILL TN3270E

The sender of this command is willing to send TN3270E information in subsequent sub-negotiations.

IAC WON'T TN3270E

The sender of this command refuses to send TN3270E information.

IAC DO TN3270E

The sender of this command is willing to receive TN3270E information in subsequent sub-negotiations.

IAC DON'T TN3270E

The sender of this command refuses to receive TN3270E information.

Note that while they are not explicitly negotiated, the equivalent of the Telnet Binary Transmission Option [3] and the Telnet End of Record Option [4] is implied in the negotiation of the TN3270E Option. That is, a party to the negotiation that agrees to support TN3270E is automatically required to support bi-directional binary and EOR transmissions.

IAC SB TN3270E SEND DEVICE-TYPE IAC SE

Only the server may send this command. This command is used to request that the client transmit a device-type and, optionally, device-name information.

IAC SB TN3270E DEVICE-TYPE REQUEST <device-type>
[[CONNECT <resource-name>] | [ASSOCIATE <device-name>]] IAC SE

Only the client may send this command. It is used in response to the server's SEND DEVICE-TYPE command, as well as to suggest another device-type after the server has sent a DEVICE-TYPE REJECT command (see below). This command requests emulation of a specific 3270 device type and model. The REQUEST command may optionally include either the CONNECT or the ASSOCIATE command (but not both). If present, CONNECT must be followed by <resource-name> and ASSOCIATE must be followed by <device-name>. (See the section entitled "DEVICE-TYPE Negotiation" for more detailed information.)

IAC SB TN3270E DEVICE-TYPE IS <device-type> CONNECT
<device-name> IAC SE

Only the server may send this command. This command is used to accept a client's DEVICE-TYPE REQUEST command and to return the server-defined device-name.

IAC SB TN3270E DEVICE-TYPE REJECT REASON <reason-code> IAC SE

Only the server may send this command. This command is used to reject a client's DEVICE-TYPE REQUEST command.

IAC SB TN3270E FUNCTIONS REQUEST <function-list> IAC SE

Either side may send this command. This command is used to suggest a set of 3270 functions that will be supported on this session. It is also sent as an implicit rejection of a previous FUNCTIONS REQUEST command sent by the other side (see the section entitled "FUNCTIONS Negotiation" for more information). Note that when used to reject a FUNCTIONS REQUEST command, the function-list must not be identical to that received in the previous REQUEST command.

IAC SB TN3270E FUNCTIONS IS <function-list> IAC SE

Either side may send this command. This command is sent as a response to a FUNCTIONS REQUEST command and implies acceptance of the set of functions sent to it in the REQUEST command. Note that the list of functions in the FUNCTIONS IS command must match the list that was received in the previous FUNCTIONS REQUEST command.

5. Default Specification

WON'T TN3270E

DON'T TN3270E

i.e., TN3270E will not be used.

6. Motivation

See the section entitled "Introduction".

7. TN3270E Sub-negotiation Rules

Once it has been agreed that TN3270E will be supported, the first sub-negotiation must concern the DEVICE-TYPE (and possibly device-name) information. Only after that has been successfully negotiated can the client and server exchange FUNCTIONS information. Only after both DEVICE-TYPE and FUNCTIONS have been successfully negotiated can 3270 data stream transmission occur.

7.1 DEVICE-TYPE Negotiation

Device-type names are NVT ASCII strings, all upper case.

Device-type (and device-name) negotiation begins when the server transmits the DEVICE-TYPE SEND command to the client. The client responds with the DEVICE-TYPE REQUEST command, which must include a device-type and may include a resource-name or device-name request.

Valid device-types are:

erminals:	IBM-3278-2	IBM-3278-2-E	(24 row x 80 col display)
	IBM-3278-3	IBM-3278-3-E	(32 row x 80 col display)
	IBM-3278-4	IBM-3278-4-E	(43 row x 80 col display)
	IBM-3278-5	IBM-3278-5-E	(27 row x 132 col display)
	IBM-DYNAMIC		(no pre-defined display size)

printers: IBM-3287-1

Note that the use of '3278' and '3287' is NOT intended to exclude any particular device capabilities; they are used here only because they are commonly known designations for a terminal and a printer member of the 3270 family of devices. The intention is to simplify the device-type negotiation (in comparison to traditional tn3270) by minimizing the number of possible device-types, and by breaking the association of a specific piece of IBM hardware with a related set of data stream capabilities. For example, negotiation of device-type

IBM-3278-2-E does NOT in and of itself preclude the use of any of the functions associated with a physical 3279 model S2B. A client's ability to support the more advanced functions of the 3270 data stream will be indicated not by negotiation of an IBM device type and model number, but rather by the combination of Read Partition Query and Query Reply.

All of the terminal device-types support a "primary" display size of 24 rows by 80 columns. The "-3", "-4" and "-5" types each support an "alternate" display size as noted in the above list. The IBM-DYNAMIC device-type implies no pre-defined alternate display size; this value will be passed from the client to host applications as part of the Query Reply structured field, and it can represent any display size the client and the host application can support.

Terminal device-types with the "-E" suffix should only be negotiated by clients that are willing to support some subset of the 3270 "extended data stream". This usually includes at a minimum support for extended colors and highlighting, but may also include a number of other functions, such as graphics capability, alternate character sets, and partitions.

Clients that negotiate a terminal device-type with the "-E" suffix or the DYNAMIC type, as well as those that negotiate a printer device-type, must be able to accept and respond to a Read Partition Query command (see the section entitled "3270 Structured Fields"). This allows the client to indicate to host applications which subsets of the 3270 extended data stream the client is willing to support.

In a VTAM/SNA environment, negotiation of IBM-DYNAMIC as the device-type should result in a Bind in which the Presentation Services Usage screen field (the eleventh byte in the logmode's PSERVIC field) is set to 0x03, indicating that the alternate screen size will be determined by the Query Reply (Usable Area).

7.1.1 Device Pools

An explanation of the CONNECT and ASSOCIATE commands first requires a discussion of the organization of terminal and printer device pools that the server maintains and from which it selects device-names to assign to session requests. Definition of a few terms is also in order.

The terms "device-name", "LU name" and "network name" can be considered interchangeable in this document. They refer to a specific terminal or printer device.

The term "resource-name" is less specific; it may refer to a device-name, but it may also be the name of a pool of printer or terminal devices. Such a named pool could serve to group devices with similar operational or administrative characteristics. In fact, this document places no restrictions on how a server makes use of resource-names, so long as the server can take a resource-name specified by the client and use it to come up with a device-name to assign to the session. Note, however, that servers must avoid allowing ambiguity; for example, they must not allow the definition of a device-name with the same name as that of a pool of devices.

Device-names and resource-names are specified as NVT ASCII strings in which upper and lower case are considered equivalent. The length of device-names and resource-names should not exceed 8 bytes.

A "generic session request" is one which includes neither the CONNECT nor the ASSOCIATE command, while a "specific session request" is one that includes either the CONNECT or the ASSOCIATE command.

If a TN3270E server wishes to support traditional tn3270 clients, it must maintain a set of terminal device-names that can be used to satisfy requests from such clients for terminal sessions. This same pool could be used to satisfy generic requests for terminal sessions from TN3270E clients.

The server may also maintain any number of other pools of device-names. For example, there could be a pool of terminal device-names reserved for a specific department within the organization, or a pool of terminal device-names that have access to certain applications on the host.

For any of these terminal device pools, the TN3270E server may also have defined a "partner" or "paired" printer device for each terminal in the pool. There should be a unique, one-to-one mapping between a terminal and its associated printer. The reasoning behind such a configuration is to allow for those host applications that produce printed output bound for a printer whose device-name is determined by the device-name of the terminal that initiated the print request. These printer devices can only be assigned to specific printer session requests that use the ASSOCIATE command (see below).

In addition, the TN3270E server may also maintain one or more pools of printer device-names that are not associated with any terminal. These printer devices can only be assigned to specific printer session requests that use the CONNECT command (see below). This allows for those host applications that generate printed output bound for a printer whose device-name is determined by something other than the device-name of the terminal that initiated the print request (for

example, when the userid of the person signed on to a terminal determines the print destination). It is also possible that a pool of printer device-names could be maintained to satisfy generic requests for printers (i.e., those that specify neither CONNECT nor ASSOCIATE).

7.1.2 CONNECT Command

CONNECT can be used by the client in two ways: if the resource-name it specifies is a device-name, then the client is requesting a specific device-name. If the specified resource-name is not a device-name, then the client is requesting any one of the device-names associated with the resource-name.

In either case, the resource indicated by the specified resource-name must not conflict with the device-type; e.g., if the client requests DEVICE-TYPE IBM-3287-1 (a printer) and specifies CONNECT T1000001, but T1000001 is a device-name defined at the host as a terminal, then the server must deny the request. Further, if the requested resource-name is a device-name already associated with some other Telnet session, or if it is not defined to the server, the server must deny the request.

7.1.3 ASSOCIATE Command

ASSOCIATE can be used by the client only when requesting a DEVICE-TYPE that represents a printer, and the specified device-name must be that of a terminal that was returned by the server in a previous DEVICE-TYPE IS <device-type> CONNECT <device-name> command.

The ASSOCIATE command requests that this session be assigned the device-name of the printer that is paired with the terminal named in the request. If the device-type does not represent a printer, or if the device-name is not that of a terminal, then the server must deny the request. Also, if the server does not have defined a partner printer for the specified terminal, it must deny the request.

The use of the ASSOCIATE command is to be as follows: A client first connects and requests a terminal from one of the terminal pools; it then uses the terminal device-name returned by the server (see "Accepting a Request", section 7.1.4 below) in a second session request, this time asking for the printer that is paired with the terminal session it just established. This allows clients to associate a printer session with a terminal rather than having to have prior knowledge of a printer device-name.

7.1.4 Accepting a Request

The server must accept the client's request or deny it as a whole - it cannot, for example, accept the DEVICE-TYPE request but deny the CONNECT portion.

If the server wishes to accept the request, it sends back the DEVICE-TYPE IS command confirming the requested device-type and the CONNECT command specifying the device-name of the terminal or printer assigned to this session.

Normally, the client should accept any DEVICE-TYPE IS <device-type> CONNECT <device-name> sent by the server. An exception to this would be if the client must (e.g., to satisfy local-site policy) be connected to a specific LU name and is presented with a device-name which does not match the one requested by the client (this could happen, for example, if the client requested what it thought was a device-name, but what was defined at the server as the name of a pool of devices). In this case, the client should reject the DEVICE-TYPE IS command by terminating TN3270E negotiations.

7.1.5 REJECT Command

If the server wishes to deny the request, it sends back the DEVICE-TYPE REJECT command with one of the following reason-codes:

Reason code name	Explanation
-----	-----
INV-DEVICE-TYPE	The server does not support the requested device-type.
INV-NAME	The resource-name or device-name specified in the CONNECT or ASSOCIATE command is not known to the server.
DEVICE-IN-USE	The requested device-name is already associated with another session.
TYPE-NAME-ERROR	The requested device-name or resource-name is incompatible with the requested device-type (such as terminal/printer mismatch).
UNSUPPORTED-REQ	The server is unable to satisfy the type of request sent by the client; e.g., a specific terminal or printer was requested but the

server does not have any such pools of device-names defined to it, or the ASSOCIATE command was used but no partner printers are defined to the server.

INV-ASSOCIATE

The client used the ASSOCIATE command and either the device-type is not a printer or the device-name is not a terminal.

CONN-PARTNER

The client used the CONNECT command to request a specific printer but the device-name requested is the partner to some terminal.

UNKNOWN-ERROR

Any other error in device type or name processing has occurred.

The process of negotiating a device-type and device-name that are acceptable to both client and server may entail several iterations of DEVICE-TYPE REQUEST and DEVICE-TYPE REJECT commands. The client must make use of the reason-code specified by the server in any DEVICE-TYPE REJECT command(s) to minimize the amount of negotiation necessary. For example, if the client initially requests that it be assigned a specific terminal device-name via the CONNECT command, and the server rejects the request with a reason-code of UNSUPPORTED-REQ, the client must make no further specific terminal requests in the negotiations. If at any point in the process either side wishes to "bail out," it can simply send a WON'T (or DON'T) TN3270E command to the other side. At this point both sides are free to negotiate other Telnet options (including traditional tn3270).

7.2 FUNCTIONS Negotiation

Once the DEVICE-TYPE negotiation has successfully completed (i.e., when the client receives a DEVICE-TYPE IS command that is acceptable), the client must initiate the FUNCTIONS negotiation by sending the FUNCTIONS REQUEST command to the server. After this initial REQUEST command, both sides are free to transmit FUNCTIONS REQUEST and FUNCTIONS IS commands as needed.

7.2.1 Commands

The FUNCTIONS REQUEST command contains a list of the TN3270E functions that the sender would like to see supported on this session. All functions not in the list are to be considered unsupported. The list is terminated by the IAC code that precedes

the SE command. Functions may appear in any order in the list.

Upon receipt of a FUNCTIONS REQUEST command, the recipient has two choices:

- it may respond in the positive (meaning it agrees to support all functions in the list, and not to transmit any data related to functions not in the list). To do this, it sends the FUNCTIONS IS command with the function-list exactly as it was received. At this point, FUNCTIONS negotiation has successfully completed.
- it may respond in the negative by sending a FUNCTIONS REQUEST command in which the function-list differs from the one it received (and not simply in the order of appearance of functions in the list; at least one function must have been added to, or removed from, the list).

To avoid endlessly looping, both parties must not add to the function-list it receives any function that it has previously added and that the other side has removed.

The process of sending FUNCTIONS REQUEST commands back and forth continues until one side receives a function-list it is willing to live with. It uses the FUNCTIONS IS command to accept the list, and, once this command is received by the other side, all necessary negotiation has been completed. At this point, 3270 data stream transmission can begin.

Note that it is possible that the function-list agreed to is null; this is referred to as "basic TN3270E". See the section entitled "Basic TN3270E" for more information.

If an impasse is reached during FUNCTIONS negotiation (for example, if a client requested and was granted a DEVICE-TYPE representing a printer, but refuses to accept either the SCS-CTL-CODES or DATA-STREAM-CTL function), then the "offended" party should terminate the negotiation by sending an IAC DON'T (or WON'T) TN3270E.

7.2.2 List of TN3270E Functions

The following list briefly describes the 3270 functions that may be negotiated in the function-list:

Function Name -----	Description -----
SCS-CTL-CODES	(Printer sessions only). Allows the use of the SNA Character Stream (SCS) and SCS control codes on the session. SCS is used with LU type 1 SNA sessions.
DATA-STREAM-CTL	(Printer sessions only). Allows the use of the standard 3270 data stream. This corresponds to LU type 3 SNA sessions.
RESPONSES	Provides support for positive and negative response handling. Allows the server to reflect to the client any and all definite, exception, and no response requests sent by the host application.
BIND-IMAGE	Allows the server to send the SNA Bind image and Unbind notification to the client.
SYSREQ	Allows the client and server to emulate some (or all, depending on the server) of the functions of the SYSREQ key in an SNA environment.

See the section entitled "Details of Processing TN3270E Functions" for a more detailed explanation of the meaning and use of these functions.

If in the process of functions negotiation an unrecognized function code is recieved, the recipient should simply remove that function code from the list and continue normal functions negotiation.

8. TN3270E Data Messages

3270 device communications are generally understood to be block oriented in nature. That is, each partner buffers data until an entire "message" has been built, at which point the data is sent to the other side. The "outbound message" (from host to device) consists of a 3270 command and a series of buffer orders, buffer addresses, and data, while the "inbound message" contains only buffer orders, addresses and data. The end of a message is understood to be

the last byte transmitted (note that this discussion disregards SNA chaining). The Telnet EOR command is used to delimit these natural blocks of 3270 data within the Telnet data stream.

In TN3270E, each 3270 message must be prefixed with a TN3270E header, which consists of five bytes and whose format is defined below (see the section entitled "The TN3270E Message Header"). A "data message" in TN3270E therefore has the following construction:

<TN3270E Header><data><IAC EOR>

It should be noted that it is possible that, for certain message types, there is no data portion present. In this case, the TN3270E data message consists of:

<TN3270E Header><IAC EOR>

If either side wishes to transmit the decimal value 255 and have it interpreted as data, it must "double" this byte. In other words, a single occurrence of decimal 255 will be interpreted by the other side as an IAC, while two successive bytes containing decimal 255 will be treated as one data byte with a value of decimal 255.

It is strongly recommended that Telnet commands (other than IAC IAC) should be sent between TN3270E data messages, with no header and no trailing IAC EOR. If a TN3270E data message containing either IAC IP (to be interpreted as 3270 Attention) or IAC A0 (to be interpreted as SYSREQ) is received, the receiver should defer processing the command until the 3270 data has been processed (see the appropriate sections for discussion of 3270 Attention and SYSREQ). If a TN3270E data message containing any other IAC-command sequence (other than IAC IAC) is received, it is implementation dependent when the IAC-command sequence will be processed, but it must be processed. The receiver may process it immediately, which in effect causes it to be processed as if it had been received before the current TN3270E data message, or the processing may be deferred until after the current TN3270E data message has been processed. It is because of this ambiguity that the presence of Telnet commands within a TN3270E data message (i.e., between the header and the trailing IAC EOR) is not recommended; neither clients nor servers should send such data.

8.1 The TN3270E Message Header

As stated earlier, each data message in TN3270E must be prefixed by a header, which consists of five bytes and is formatted as follows:

```

-----
| DATA-TYPE | REQUEST-FLAG | RESPONSE-FLAG | SEQ-NUMBER |
-----
      1 byte       1 byte       1 byte       2 bytes

```

8.1.1 DATA-TYPE Field

The DATA-TYPE field indicates how the data portion of the message is to be interpreted by the receiver. Possible values for the DATA-TYPE field are:

Data-type Name	Code	Meaning
-----	----	-----
3270-DATA	0x00	The data portion of the message contains only the 3270 data stream.
SCS-DATA	0x01	The data portion of the message contains SNA Character Stream data.
RESPONSE	0x02	The data portion of the message constitutes device-status information and the RESPONSE-FLAG field indicates whether this is a positive or negative response (see below).
BIND-IMAGE	0x03	The data portion of the message is the SNA bind image from the session established between the server and the host application.
UNBIND	0x04	The data portion of the message is an Unbind reason code.
NVT-DATA	0x05	The data portion of the message is to be interpreted as NVT data.
REQUEST	0x06	There is no data portion present in the message. Only the REQUEST-FLAG field has any meaning.
SSCP-LU-DATA	0x07	The data portion of the message is data from the SSCP-LU session.

PRINT-E0J	0x08	There is no data portion present in the message. This value can be sent only by the server, and only on a printer session.
-----------	------	--

8.1.2 REQUEST-FLAG Field

The REQUEST-FLAG field only has meaning when the DATA-TYPE field has a value of REQUEST; otherwise, the REQUEST-FLAG field must be ignored by the receiver and should be set to 0x00 by the sender. Possible values for the REQUEST-FLAG field are:

Request-Flag Name	Code	Meaning
-----	----	-----
ERR-COND-CLEARED	0x00	The client sends this to the server when some previously encountered printer error condition has been cleared. (See the section entitled "The RESPONSES Function" below.)

8.1.3 RESPONSE-FLAG Field

The RESPONSE-FLAG field only has meaning for certain values of the DATA-TYPE field. For DATA-TYPE field values of 3270-DATA and SCS-DATA, the RESPONSE-FLAG is an indication of whether or not the sender of the data expects to receive a response. In this case the possible values of RESPONSE-FLAG are:

Response-Flag Name	Code	Meaning
-----	----	-----
NO-RESPONSE	0x00	The sender does not expect the receiver to respond either positively or negatively to this message. The receiver must therefore not send any response to this data-message.
ERROR-RESPONSE	0x01	The sender only expects the receiver to respond to this message if some type of error occurred, in which case a negative response must be sent by the receiver.
ALWAYS-RESPONSE	0x02	The sender expects the receiver to respond negatively if an error occurs, or positively if no errors occur. One or the other must always be sent by the receiver.

For a DATA-TYPE field value of RESPONSE, the RESPONSE-FLAG is an actual response to a previous data message (which must by definition have had a DATA-TYPE of either 3270-DATA or SCS-DATA and a RESPONSE-FLAG value of either ERROR-RESPONSE or ALWAYS-RESPONSE). In this case the possible values of RESPONSE-FLAG are:

Response-Flag Name	Code	Meaning
-----	----	-----
POSITIVE-RESPONSE	0x00	The previous message was received and executed successfully with no errors.
NEGATIVE-RESPONSE	0x01	The previous message was received but an error(s) occurred while processing it.

Accompanying status information will be found in the data portion of the message.

For any other values of the DATA-TYPE field, the RESPONSE-FLAG field must be ignored by the receiver and should be set to 0x00 by the sender.

8.1.4 SEQ-NUMBER Field

The SEQ-NUMBER field is only used when the RESPONSES function has been agreed to. It contains a 2 byte binary number, and is used to correlate positive and negative responses to the data messages for which they were intended. This field must be sent in network byte order ("big endian"). If either byte contains a 0xff, it should be doubled to 0xffff before sending and stripped back to 0xff upon receipt; this is standard IAC escaping. See the section entitled "The RESPONSES Function" for further information on the use of the SEQ-NUMBER field. When the RESPONSES function is not agreed to, this field should always be set to 0x0000 by the sender and ignored by the receiver.

9. Basic TN3270E

As has been stated earlier, whether or not the use of each of the TN3270E functions is allowed on a session is negotiated when the connection is established. It is possible that none of the functions are agreed to (in this case, the function-list in the FUNCTIONS REQUEST and FUNCTIONS IS commands is null). This mode of operation is referred to as "basic TN3270E". Note that, since neither the SCS-CTL-CODES function nor the DATA-STREAM-CTL function is agreed to, basic TN3270E refers to terminal sessions only.

Basic TN3270E requires the support of only the following TN3270E header values:

Header field	Value
-----	-----
DATA-TYPE	3270-DATA
DATA-TYPE	NVT-DATA

The REQUEST-FLAG, RESPONSE-FLAG and SEQ-NUMBER fields are not used in basic TN3270E.

9.1 3270 Mode and NVT Mode

At any given time, a TN3270E connection can be considered to be operating in either "3270 mode" or "NVT mode". In 3270 mode, each party may send data messages with the DATA-TYPE flag set to 3270-DATA; sending a DATA-TYPE flag set to NVT-DATA constitutes a request to switch modes. In NVT mode, each party may send data messages with the DATA-TYPE flag set to NVT-DATA; sending 3270-DATA is a request to switch modes. The connection is initially in 3270 mode when TN3270E operation is successfully negotiated. When a party receives a message with a DATA-TYPE different from the mode it is operating in, the mode of operation for the connection is switched. Switching modes results in the client performing the equivalent of a 3270 Erase/Reset operation, as described in [5], using the default partition (screen) size. The server cannot assume the client preserves any attributes of the previous environment across a mode switch.

Note that even when sending NVT-DATA, each side should buffer data until an entire message is built (for the client, this would normally mean until the user presses Enter). At that point, a complete TN3270E data message should be built to transmit the NVT data.

Typically, NVT data is used by a server to interact with the user of a client. It allows the server to do this using a simple NVT data stream, instead of requiring a 3270 data stream. An example would be a server which displays a list of 3270 applications to which it can connect the client. The server would use NVT data to display the list and read the user's choice. Then the server would connect to the application, and begin the exchange of 3270 data between the application and the client.

10. Details of Processing TN3270E Functions

Agreement by both parties to a specific function in the FUNCTIONS REQUEST function-list implies agreement by each party to support a related set of values in the TN3270E header. It also implies a willingness to adhere to the rules governing the processing of data messages with regard to the agreed upon function. Either party that fails to accept header values associated either with agreed upon functions or with basic TN3270E, or attempts to use header values associated with a function that is not a part of basic TN3270E and was not agreed upon, will be considered non-conforming and in violation of the protocol. The following sections detail for each TN3270E function the associated header values and processing rules.

10.1 The SCS-CTL-CODES Function

This function can only be supported on a 3270 printer session.

Agreement to support this function requires that the party support the following TN3270E header values:

Header field	Value
-----	-----
DATA-TYPE	SCS-DATA
DATA-TYPE	PRINT-EOJ

A client representing a printer device uses this function to indicate its willingness to accept a data stream that includes SCS control codes. For the purposes of NVT mode versus 3270 mode, SCS-DATA must be treated exactly like 3270-DATA (i.e., it can cause a switch from NVT mode to 3270 mode).

When a printer device-type has been negotiated, either the SCS-CTL-CODES function or the DATA-STREAM-CTL function, or both, must be negotiated. This enables the server to know when it should and should not accept a session with a host application on behalf of the client. If only the SCS-CTL-CODES function is agreed to, then the server will not establish sessions with host applications that would send 3270 data stream control. If both SCS-CTL-CODES and DATA-STREAM-CTL are agreed to, then the server will establish sessions both with host applications that would send SCS control codes and with those that would send 3270 orders.

The server should send a TN3270E message with DATA-TYPE set to PRINT-EOJ at the end of each print job to indicate to the client that it may now take whatever action is appropriate for its environment (e.g., close a disk or spool file, etc.). The server may have multiple criteria for determining when it should send a PRINT-EOJ,

such as receipt of SNA End Bracket from the host application, or expiration of a pre-defined timeout value.

10.2 The DATA-STREAM-CTL Function

This function can only be supported on a 3270 printer session.

Agreement to support this function requires that the party support the following TN3270E header values:

Header field	Value
-----	-----
DATA-TYPE	3270-DATA
DATA-TYPE	PRINT-EOJ

A client representing a printer device uses this function to indicate its willingness to accept a data stream that includes 3270 orders and attributes.

When a printer device-type has been negotiated, either the SCS-CTL-CODES function or the DATA-STREAM-CTL function, or both, must be negotiated. This enables the server to know when it should and should not accept a session with a host application on behalf of the client. If only the DATA-STREAM-CTL function is agreed to, then the server will not establish sessions with host applications that would send SCS control codes in a data stream. If both SCS-CTL-CODES and DATA-STREAM-CTL are agreed to, then the server will establish sessions both with host applications that would send SCS control codes and with those that would send 3270 orders.

The server should send a TN3270E message with DATA-TYPE set to PRINT-EOJ at the end of each print job to indicate to the client that it may now take whatever action is appropriate for its environment (e.g., close a disk or spool file, etc.). The server may have multiple criteria for determining when it should send a PRINT-EOJ, such as receipt of SNA End Bracket from the host application, or expiration of a pre-defined timeout value.

10.3 The BIND-IMAGE Function

This function can only be supported when the TN3270E server represents SNA terminals and printers.

Agreement to support this function requires that the party support the following TN3270E header values:

Header field	Value
-----	-----
DATA-TYPE	BIND-IMAGE
DATA-TYPE	UNBIND
DATA-TYPE	SSCP-LU-DATA

When BIND-IMAGE is in effect, the server must inform the client when an SNA session has been established with a host application, and when such a session has been terminated. It uses DATA-TYPE values of BIND-IMAGE and UNBIND to convey this information.

When establishing an SNA session on behalf of a client, the server will receive a Bind RU from the host application. It will also receive a Start Data Traffic RU. Once both of these have been responded to positively by the server, it must then inform the client of the presence of this session by sending it a data message with the DATA-TYPE flag set to BIND-IMAGE. The data portion of this message must contain the bind image exactly as it was received in the Bind RU that the server accepted on behalf of the client. The format and maximum length of this bind image are defined in [6].

When an SNA session between the server and a host application is terminated, the server must send a data message to the client with the DATA-TYPE flag set to UNBIND. If the server was notified of the session termination via an SNA Unbind RU, it should include the Unbind reason code in the data portion of the message it sends to the client. If the server itself requested the SNA session termination (for example, as part of SYSREQ key processing), it should set the data portion of the UNBIND message to 0x01, indicating "normal end of session".

Another aspect of the BIND-IMAGE function alters the allowable DATA-TYPE flag values slightly from the behavior described in the section entitled "Basic TN3270E". When BIND-IMAGE is in effect, data messages with DATA-TYPE set to 3270-DATA or SCS-DATA are not allowed before the first BIND-IMAGE is received by the client; only SSCP-LU-DATA or NVT-DATA can be used to transmit user-oriented data. The same applies to data messages exchanged after an UNBIND is sent and before another BIND-IMAGE is received by the client. Once the client receives a BIND-IMAGE data message, the allowable DATA-TYPE values,

in addition to SSCP-LU-DATA, now include 3270-DATA and/or SCS-DATA, depending on whether a terminal or printer device-type was negotiated, and whether a printer client agreed to DATA-STREAM-CTL or SCS-CTL-CODES, or both. (See the section entitled "The SYSREQ Function" for further discussion of the SSCP-LU session in an SNA environment.)

10.4 The RESPONSES Function

This function can be supported for both terminal and printer sessions connected to both SNA and non-SNA servers.

Agreement to support this function requires that the party support the following TN3270E header values:

Header field	Value
-----	-----
DATA-TYPE	RESPONSE
DATA-TYPE	REQUEST
RESPONSE-FLAG	-all values-
REQUEST-FLAG	ERR-COND-CLEARED
SEQ-NUMBER	binary values from 0-32767

Whenever a data message is sent with a DATA-TYPE of either SCS-DATA or 3270-DATA, the sender must set the RESPONSE-FLAG field to either NO-RESPONSE, ERROR-RESPONSE, or ALWAYS-RESPONSE. It is anticipated that the client side will normally set RESPONSE-FLAG to NO-RESPONSE. The server, if it represents an SNA device, should set RESPONSE-FLAG to reflect the response value set in the RH of the RU that generated this data message - Definite Response resulting in a RESPONSE-FLAG value of ALWAYS-RESPONSE, Exception Response resulting in ERROR-RESPONSE being set, and No Response causing a setting of NO-RESPONSE. A non-SNA server should set RESPONSE-FLAG to ERROR-RESPONSE.

In addition, the sender must keep a count of the messages with a DATA-TYPE of 3270-DATA or SCS-DATA that it sends on a given TN3270E session. This counter should start at zero for the first such message, and be incremented by one for each subsequent message. Note that this counter is independent of any SNA sequence numbers, and should not be reset to zero as a result of Bind or Unbind. If the counter reaches the maximum of 32767, it should be restarted at zero. The sender must place this value in the SEQ-NUMBER field of the TN3270E header before it sends the message. Note that the SEQ-NUMBER field must be set regardless of the value of the RESPONSE-FLAG field.

10.4.1 Response Messages

Whenever a data message with a DATA-TYPE of either SCS-DATA or 3270-DATA is received, the receiver must attempt to process the data in the data portion of the message, then determine whether or not it should send a data message with a DATA-TYPE of RESPONSE. If the data message it has just processed had a RESPONSE-FLAG value of NO-RESPONSE, or if it had a value of ERROR-RESPONSE and there were no errors encountered while processing the data, then no RESPONSE type message should be sent. Otherwise, a data message should be sent in which the header DATA-TYPE field is set to RESPONSE, and in which the SEQ-NUMBER field is a copy of the SEQ-NUMBER field from the message to which this response corresponds. The RESPONSE-FLAG field in this header must have a value of either POSITIVE-RESPONSE or NEGATIVE-RESPONSE. A POSITIVE-RESPONSE should be sent if the previously processed message's header specified ALWAYS-RESPONSE and no errors were encountered in processing the data. A NEGATIVE-RESPONSE should be sent when

- 1) the previously processed message specified ERROR-RESPONSE or ALWAYS-RESPONSE and
- 2) some kind of error occurred while processing the data.

Normally only the client will be constructing and sending these RESPONSE messages. A negative response sent by the client to the server is the equivalent of a Unit Check Status [7]. All references to device status and sense codes in this section rely on [7].

The data portion of a RESPONSE message must consist of one byte of binary data. The value of this byte gives a more detailed account of the results of having processed the previously received data message. The possible values for this byte are:

For a RESPONSE-FLAG value of POSITIVE-RESPONSE -

Value	Meaning
-----	-----
0x00	Successful completion (when sent by the client, this is equivalent to "Device End").

For a RESPONSE-FLAG value of NEGATIVE-RESPONSE -

Value	Meaning
-----	-----
0x00	An invalid 3270 command was received (equivalent to "Command Reject").

- 0x01 Printer is not ready (equivalent to "Intervention Required").
- 0x02 An illegal 3270 buffer address or order sequence was received (equivalent to "Operation Check").
- 0x03 Printer is powered off or not connected (equivalent to "Component Disconnected").

When the server receives any of the above responses, it should pass along the appropriate information to the host application. The appropriate information is determined by whether the server represents an SNA or a non-SNA device.

An SNA server should pass along a POSITIVE-RESPONSE from the client as an SNA positive Response Unit to the host application. It should translate a NEGATIVE-RESPONSE from the client into an SNA negative Response Unit in which the Sense Data Indicator bit is on and which contains one of the following sense codes:

RESPONSE-FLAG -----	Equivalent -----	SNA Sense Code -----
0x00	Command Reject	0x10030000
0x01	Intervention Required	0x08020000
0x02	Operation Check	0x10050000
0x03	Component Disconnected	0x08310000

A non-SNA server should pass along a POSITIVE-RESPONSE from the client by setting the Device End Status bit on. It should reflect a NEGATIVE-RESPONSE from the client by setting the Unit Check Status Bit on, and setting either the Command Reject, Intervention Required, or Operation Check Sense bit on when responding to the Sense command.

In the case of Intervention Required or Component Disconnected being passed by the server to the host application, the host would normally refrain from sending any further data to the printer. If and when the error condition at the client has been resolved, the client must send to the server a data message whose header DATA-TYPE field is set to REQUEST, and whose REQUEST-FLAG is set to ERR-COND-CLEARED. Note that this message has no data portion. Upon receipt of this message, the server should pass along the appropriate information to the host application so that it may resume sending printer output. Again, the form of this information depends on whether the server represents an SNA or a non-SNA device.

An SNA server should reflect an ERR-COND-CLEARED to the host application by sending an SNA LUSTAT RU with one of the following sense codes:

- if the previous error condition was an Intervention Required, the server should send sense code 0x00010000
- if the previous error condition was Component Disconnected, the server should send sense code 0x082B0000

A non-SNA server should set the corresponding bits in the Ending Status and Sense Condition bytes.

10.5 The SYSREQ Function

This function can only be supported when the TN3270E server represents SNA devices.

Agreement to support this function requires that the party support the following TN3270E header values:

Header field	Value
-----	-----
DATA-TYPE	SSCP-LU-DATA

The 3270 SYSREQ key can be useful in an SNA environment when the ATTN key is not sufficient to terminate a process. (See the section entitled "The 3270 ATTN Key" for more information.)

10.5.1 Background

In SNA, there is a session between the host application (the PLU, or Primary Logical Unit) and the TN3270E server representing the client (the SLU, or Secondary Logical Unit). This is referred to as the PLU-SLU session, and it is the one on which normal communications flow. There is also a session between the host telecommunications access method (the SSCP, or System Services Control Point) and the SLU, and it is referred to as the SSCP-LU session. This session is used to carry various control information and is normally transparent to the user; normal 3270 data stream orders are not allowed in this data. For more information, refer to [7].

The terminal display and keyboard are usually "owned" by the PLU-SLU session, meaning any data the user types is sent to the host application. The SYSREQ key is used to toggle ownership of the keyboard and display between the PLU-SLU session and the SSCP-LU session. In other words, the user is able to press SYSREQ and then communicate directly with the host SSCP. The user may then enter any

valid Unformatted Systems Services commands, which are defined in the USS table associated with the SLU. The most common USS command users employ is "LOGOFF," which requests that the SSCP immediately terminate the PLU-SLU session. The usual reason for requesting such an action is that the host application (the PLU) has stopped responding altogether.

Whenever the keyboard and display are owned by the SSCP-LU session, no data is allowed to flow in either direction on the PLU-SLU session. Once "in" the SSCP-LU session, the user may decide to switch back to the PLU-SLU session by again pressing the SYSREQ key.

10.5.2 TN3270E Implementation of SYSREQ

The design of some TN3270E servers allows them to fully support the SYSREQ key because they are allowed to send USS commands on the SSCP-LU session. Other TN3270E servers operate in an environment which does not allow them to send USS commands to the SSCP; this makes full support of the SYSREQ key impossible. For such servers, TN3270E provides for emulation of a minimal subset of functions, namely, for the sequence of pressing SYSREQ and typing LOGOFF that many users employ to immediately terminate the PLU-SLU session.

The Telnet Abort Output (AO) command is the mechanism used to implement SYSREQ key support in TN3270E because, in a real SNA session, once the user presses the SYSREQ key, the host application is prevented from sending any more output to the terminal (unless the user presses SYSREQ a second time), but the user's process continues to execute.

In order to implement SYSREQ key support, TN3270E clients that have agreed to the SYSREQ function should provide a key (or combination of keys) that is identified as mapping to the 3270 SYSREQ key. When the user presses this key(s), the client should transmit a Telnet AO command to the server.

Upon receipt of the AO command, a TN3270E server that has agreed to the SYSREQ function should enter what will be loosely termed "suspended mode" for the connection. If a server that has not agreed to the SYSREQ function receives an AO command, it should simply ignore it. Any attempt by the host application to send data to the client while the connection is "suspended" should be responded to by the server with a negative response, sense code 0x082D, indicating an "LU Busy" condition. The server should not transmit anything to the client on behalf of the host application. While the connection is "suspended," any data messages exchanged between the client and server should have the DATA-TYPE flag set to SSCP-LU-DATA; the data stream will be as defined in [7], specifically the section entitled

"Operation in SSCP-SLU Session."

At this point, the behavior of the server depends upon whether or not it is allowed to send USS commands on the SSCP-LU session. Servers that have this ability should simply act as a vehicle for passing USS commands and responses between the client and the SSCP.

Servers that are not allowed to send USS commands on the SSCP-LU session should behave as follows:

- if the user transmits the string LOGOFF (upper or lower case), the server should send an Unbind SNA RU to the host application. This will result in termination of the PLU-SLU session. If the BIND-IMAGE function was agreed upon, then the server should also send a data message to the client with the DATA-TYPE flag set to UNBIND and the data portion set to 0x01.
- if the user transmits anything other than LOGOFF, the server should respond with the string "COMMAND UNRECOGNIZED" to the client. The server should not send anything to the host application on behalf of the client.

Regardless of which kind of server is present (i.e., whether or not it may send USS commands on the SSCP-LU session), while the connection is suspended, the user may press the "SYSREQ" key again. This will result in the transmission of another A0 to the server. The server should then send to the host application an LUSTAT RU with a value of 0x082B indicating "presentation space integrity lost". The server will then "un-suspend" the Telnet connection to the client, meaning it will allow the host application to once again send data to the client.

11. The 3270 ATTN Key

The 3270 ATTN key is interpreted by many host applications in an SNA environment as an indication that the user wishes to interrupt the execution of the current process. The Telnet Interrupt Process (IP) command was defined expressly for such a purpose, so it is used to implement support for the 3270 ATTN key. This requires two things:

- TN3270E clients should provide as part of their keyboard mapping a single key or a combination of keys that map to the 3270 ATTN key. When the user presses this key(s), the client should transmit a Telnet IP command to the server.
- TN3270E servers should translate the IP command received from a TN3270E client into the appropriate form and pass it along to the host application as an ATTN key. In other words, the

server representing an SLU in an SNA session should send a SIGNAL RU to the host application.

The ATTN key is not supported in a non-SNA environment; therefore, a TN3270E server representing non-SNA 3270 devices should ignore any Telnet IP commands it receives from a client.

12. 3270 Structured Fields

3270 structured fields provide a much wider range of features than "old-style" 3270 data, such as support for graphics, partitions and IPDS printer data streams. It would be unreasonable to expect all TN3270E clients to support all possible structured field functions, yet there must be a mechanism by which those clients that are capable of supporting some or all structured field functions can indicate their wishes.

The design of 3270 structured fields provides a convenient means to convey the level of support (including no support) for the various structured field functions. This mechanism is the Read Partition Query command, which is sent from the host application to the device. The device responds with a Query Reply structured field(s) listing which, if any, structured field functions it supports.

The Query Reply is also used to indicate some device capabilities which do not require the use of structured fields, such as extended color support and extended highlighting capability. Most host applications will use Read Partition Query to precisely determine a device's capabilities when there has been some indication that the device supports the "extended data stream".

Therefore, all TN3270E clients that negotiate a terminal device-type that contains a "-E" suffix, the DYNAMIC terminal type, or a printer device-type, must be able to respond to a Read Partition Query command. Note that these clients must support both the Read Partition Query (Type 02), and all forms of the Read Partition Query List (Type 03).

13. Implementation Guidelines

13.1 3270 Data Stream Notes

Implementors of TN3270E clients should note that the command codes for the various 3270 Read and Write commands have different values depending on how the server is connected to the host (local versus remote, SNA versus non-SNA). Clients should be coded to check for the various possible values if they wish to be compatible with the widest range of servers. See [7] for further details.

13.2 Negotiation of the TN3270E Telnet Option

Since TN3270E is a Telnet Option governed by [8], both client and server are free to attempt to initiate negotiation of TN3270E by sending a DO TN3270E command. However, just as is usually the case with the Telnet DO TERMINAL-TYPE, it is anticipated that the server will normally be the one sending the DO TN3270E, and the client will be responding with a WILL or a WON'T TN3270E.

13.3 A "Keep-alive" Mechanism

In many environments, it is very helpful to have in place a mechanism that allows timely notification of the loss of a 3270 session. TN3270E does not require that any form of keep-alive mechanism be employed by either clients or servers, but implementors wishing to support such a mechanism should consider the following guidelines.

There are at least three possible means of providing a keep-alive mechanism in TN3270E: the TCP Keepalive, the Telnet IAC NOP command [8], and the Telnet DO TIMING-MARK option [9]. Each method has its advantages and disadvantages. It is recommended that TN3270E clients and servers that support keep-alives should support all three methods, and that both sides should always respond to TIMING-MARKs.

Note that both clients and servers could be configured to "actively" implement keep-alives. That is, both sides could send a TIMING-MARK or a NOP or issue a TCP Keepalive in order to determine whether or not the partner is still alive. Alternatively, network administrators may wish to configure only one side to send keep-alives; in this case, the other side would be a "passive" participant which simply responds to the keep-alives it receives.

Implementors who want their code to be capable of being an "active" keep-alive participant should make their client or server configurable so that administrators can set which, if any, keep-alive mechanism should be employed, and how often it should be used.

Upon failure of a session on which keep-alives are used, both parties should make the proper notifications. A client should give the user some indication of the failure, such as an error code in the Operator Information Area of the screen. A server should notify the host application that the session has been terminated, for example by sending an UNBIND with type CLEANUP in an SNA environment.

13.4 Examples

The following example shows a TN3270E-capable server and a traditional tn3270 client establishing a connection:

```

Server:  IAC DO TN3270E
Client:  IAC WON'T TN3270E
Server:  IAC DO TERMINAL-TYPE
Client:  IAC WILL TERMINAL-TYPE
Server:  IAC SB TERMINAL-TYPE SEND IAC SE
Client:  IAC SB TERMINAL-TYPE IS IBM-3278-2 IAC SE
Server:  IAC DO EOR IAC WILL EOR
Client:  IAC WILL EOR IAC DO EOR
Server:  IAC DO BINARY IAC WILL BINARY
Client:  IAC WILL BINARY IAC DO BINARY
        (3270 data stream is exchanged)

```

The following example shows a TN3270E-capable server and a TN3270E-capable client establishing a generic pool (non-specific) terminal session:

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3278-2 IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3278-2 CONNECT
        anyterm IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST RESPONSES IAC SE
Server:  IAC SB TN3270E FUNCTIONS IS RESPONSES IAC SE
        (3270 data stream is exchanged)

```

The following example shows a TN3270E-capable server and a TN3270E-capable client establishing a terminal session where the client requests a specific device-name:

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3278-5-E
        CONNECT myterm IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3278-5-E CONNECT
        myterm IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST RESPONSES
        BIND-IMAGE IAC SE
Server:  IAC SB TN3270E FUNCTIONS IS RESPONSES BIND-IMAGE
        IAC SE
        (3270 data stream is exchanged)

```

The following example shows a TN3270E-capable server and a TN3270E-capable client establishing a terminal session where the client requests a resource-name and is returned a device-name chosen by the server:

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3278-5-E
        CONNECT pool1 IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3278-5-E CONNECT
        term0013 IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST BIND-IMAGE IAC SE
Server:  IAC SB TN3270E FUNCTIONS IS BIND-IMAGE IAC SE
        (3270 data stream is exchanged)

```

The following example shows a TN3270E-capable server and a TN3270E-capable client attempting to establish a terminal session; multiple attempts are necessary because the device-name initially requested by the client is already in use:

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3278-5
        CONNECT myterm IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE REJECT REASON
        DEVICE-IN-USE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3278-2
        CONNECT herterm IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3278-2 CONNECT
        herterm IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST RESPONSES IAC SE
Server:  IAC SB TN3270E FUNCTIONS IS RESPONSES IAC SE
        (3270 data stream is exchanged)

```

The following example shows a TN3270E-capable server and a TN3270E-capable client establishing a printer session where the client requests a specific device-name, and where some amount of 3270 function negotiation is required before an agreement is reached:

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3287-1 CONNECT
        myprt IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3287-1 CONNECT
        myprt IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST DATA-STREAM-CTL IAC
Server:  IAC SB TN3270E FUNCTIONS REQUEST DATA-STREAM-CTL
        RESPONSES IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST DATA-STREAM-CTL IAC
Server:  IAC SB TN3270E FUNCTIONS IS DATA-STREAM-CTL IAC SE

```

(3270 data stream is exchanged)

The following example shows a TN3270E-capable server and a TN3270E-capable client establishing first a specific terminal session, then a printer session where the "partner" printer for the assigned terminal is requested:

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3278-2 CONNECT
          termxyz IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3278-2 CONNECT
          termxyz IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST RESPONSES IAC SE
Server:  IAC SB TN3270E FUNCTIONS IS RESPONSES IAC SE
        (3270 data stream is exchanged)

```

(user decides to request a printer session,
so client again connects to Telnet port on server)

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3287-1
          ASSOCIATE termxyz IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3287-1 CONNECT
          termxyz's-prt IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST SCS-CTL-CODES
          RESPONSES IAC SE
Server:  IAC SB TN3270E FUNCTIONS IS SCS-CTL-CODES RESPONSES
          IAC SE
        (3270 data stream is exchanged)

```

The following example shows a TN3270E-capable server and a TN3270E-capable client establishing first a terminal session where a resource-name was requested and a server chosen device-name was returned, then a printer session where the "partner" printer for the assigned terminal is requested:

```

Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3278-5 CONNECT
          poolxyz IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3278-5 CONNECT
          terma IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST RESPONSES IAC SE

```

```

Server:  IAC SB TN3270E FUNCTIONS IS RESPONSES IAC SE
        (3270 data stream is exchanged)
        .
        .
        .
        (user decides to request a printer session,
         so client again connects to Telnet port on server)
Server:  IAC DO TN3270E
Client:  IAC WILL TN3270E
Server:  IAC SB TN3270E SEND DEVICE-TYPE IAC SE
Client:  IAC SB TN3270E DEVICE-TYPE REQUEST IBM-3287-1
        ASSOCIATE terma IAC SE
Server:  IAC SB TN3270E DEVICE-TYPE IS IBM-3287-1 CONNECT
        terma's-prt IAC SE
Client:  IAC SB TN3270E FUNCTIONS REQUEST SCS-CTL-CODES
        RESPONSES IAC SE
Server:  IAC SB TN3270E FUNCTIONS IS SCS-CTL-CODES RESPONSES
        IAC SE
        (3270 data stream is exchanged)

```

14. Security Considerations

These extensions to telnet do not provide any security features beyond that of ordinary telnet; so a TN3270E session is no more secure than an ordinary telnet session. Once standard authentication and/or privacy mechanisms for telnet have been defined, these may also be usable by TN3270E. One of the important uses of authentication would be to answer the question of whether or not a given user should be allowed to "use" a specific terminal or printer device-name.

15. References

- [1] Rekhter, J., "Telnet 3270 Regime Option", RFC 1041, January 1988.
- [2] VanBokkelen, J., "Telnet Terminal-Type Option", RFC 1091, February 1989.
- [3] Postel, J., and J. Reynolds, "Telnet Binary Transmission", STD 27, RFC 856, May 1983.
- [4] Postel, J., "Telnet End of Record Option", RFC 885, December 1983.
- [5] "3270 Information Display System - Data Stream Programmer's Reference", publication number GA24-0059, IBM Corporation.
- [6] "SNA Formats", publication number GA27-3136, IBM Corporation.

[7] "3174 Establishment Controller Functional Description", publication number GA23-0218, IBM Corporation.

[8] Postel, J., and J. Reynolds, "Telnet Protocol Specification", STD 8, RFC 854, May 1983.

[9] Postel, J., and J. Reynolds, "Telnet Timing Mark Option", STD 31, RFC 860, May 1983.

[10] J. Penner, "TN3270 Current Practices", RFC 1576, January, 1994.

16. Author's Note

Portions of this document were drawn from the following sources:

- A White Paper written by Owen Reddecliffe, WRQ Corporation, October 1991.
- Experimental work on the part of Cleve Graves and Michelle Angel, OpenConnect Systems, 1992 - 1993.
- Discussions at the 1993 IETF meetings.
- Discussions on the "TN3270E" list, 1993-94 and 1997.

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