Point-to-Point Protocol (PPP)

User Guide

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Contents

Chapter 1 Introduction to PPP 4
PPP Serial Communication 4
PPP Over Ethernet Communication 5
PPP Packet 5
Link Control Protocol (LCP) 6
Password Authentication Protocol (PAP) 6
Challenge-Handshake Authentication Protocol (CHAP) 6
Internet Protocol Control Protocol (IPCP) 7
Data Transfer 7
PPP RFCs 7
Chapter 2 Installation and Use of PPP 8
Product Distribution 8
PPP Installation 8
Using PPP 8
Using Modems 8
Small Example System 11
Configuration Options 13
Chapter 3 Description of PPP Services 18
nx_ppp_byte_receive 20
nx_ppp_chap_challenge 21
nx_ppp_chap_enable 22
nx_ppp_create 25
nx_ppp_delete 27
nx_ppp_dns_address_get 28
nx_ppp_secondary_dns_address_get 29
nx_ppp_dns_address_set 30
nx_ppp_secondary_dns_address_set 31
nx_ppp_interface_index_get 32
nx_ppp_ip_address_assign 33
nx_ppp_link_down_notify 34
nx_ppp_link_up_notify 35
nx_ppp_nak_authentication_notify 36
nx_ppp_pap_enable 37
nx_ppp_ping_request 39
nx_ppp_raw_string_send 41
nx_ppp_restart 42
nx_ppp_status_get 43
nx_ppp_packet_receive 45
nx_ppp_packet_send_set 46

Chapter 1

Introduction to PPP

Typically, NetX applications connect to the actual physical network through Ethernet. This provides network access that is both fast and efficient. However, there are situations where the application does not have Ethernet access. In such cases, the application may still connect to the network through a serial interface connected directly to another network member. The most common software protocol used to manage such a connection is the Point-to-Point Protocol (PPP).

Although serial communication is relatively straightforward, the PPP is somewhat complex. The PPP is actually comprised of multiple protocols, such as the Link Control Protocol (LCP), Internet Protocol Control Protocol (IPCP), Password Authentication Protocol (PAP), and the Challenge-Handshake Authentication Protocol (CHAP). The LCP is the main protocol for PPP. This is where the basic components of the link are dynamically negotiated in a peer-to-peer fashion. Once the basic characteristics of the link have been successfully negotiated, the PAP and/or CHAP are used to ensure a connected peer is valid. If both peers are valid, the IPCP is then utilized to negotiate the IP addresses used by the peers. Once IPCP completes, PPP is then able to send and receive IP packets.

NetX views the PPP primarily as a device driver. The *nx_ppp_driver* function is supplied to the NetX IP create function, *nx_ip_create*. Otherwise, NetX does not have any direct knowledge of PPP.

PPP Serial Communication

The NetX PPP package requires the application to provide a serial communication driver. The driver must support 8-bit characters and may also employ software flow control. It is the application's responsibility to initialize the driver, which should be done prior to creating the PPP instance.

In order to send PPP packets, a serial driver output byte routine must be provided to PPP (specified in the *nx_ppp_create* function). This serial driver byte output routine will be called repetitively in order to transmit the entire PPP packet. It is the serial driver's responsibility to buffer the output. On the receive side, the application's serial driver must call the PPP *nx_ppp_byte_receive* function whenever a new byte arrives. This is

typically done from within the context of an Interrupt Service Routine (ISR). The *nx_ppp_byte_receive* function places the incoming byte into a circular buffer and alerts the PPP receive thread of its presence.

PPP Over Ethernet Communication

NetX PPP also can transmit PPP message over Ethernet, in this situation, the NetX PPP package requires the application to provide an Ethernet communication driver.

In order to send PPP packets over Ethernet, an output routine must be provided to PPP (specified in the *nx_ppp_packet_send_set* function). This output routine will be called repetitively in order to transmit the entire PPP packet. On the receive side, the application's receiver must call the PPP *nx_ppp_packet_receive* function whenever a new packet arrives.

PPP Packet

PPP utilizes AHDLC framing (a subset of HDLC) for encapsulating all PPP protocol control and user data. An AHDLC frame looks like the following:

Flag	**Addr**	**Ctrl**	**Information**	**CRC**	**Flag**
7E	FF	03	[0-1502 bytes]	2-byte	7E

Each and every PPP frame has this overall appearance. The first two bytes of the information field contain the PPP protocol type. Valid values are defined as follows:

C021	LCP
8021	IPCP
C023	PAP
C223	CHAP
0021	IP Data Packet

If the 0x0021 protocol type is present, the IP packet follows immediately. Otherwise, if one of the other protocols is present, the following bytes correspond to that particular protocol.

In order to ensure unique 0x7E beginning/end-of frame markers and to support software flow control, AHDLC uses escape sequences to represent various byte values. The 0x7D value specifies that the character following is encoded, which is basically the original character exclusive ORed with 0x20. For example, the 0x03 value for the Ctrl field in the header is represented by the two byte sequence: 7D 23. By default,

values less than 0x20 are converted into an escape sequence, as well as 0x7E and 0x7D values found in the Information field. Note that escape sequences also apply to the CRC field.

Link Control Protocol (LCP)

The LCP is the primary PPP protocol and is the first protocol to run. LCP is responsible for negotiating various PPP parameters, including the Maximum Receive Unit (MRU) and the Authentication Protocol (PAP, CHAP, or none) to use. Once both sides of LCP agree on PPP parameters, the authentication protocols—if any—then start running.

Password Authentication Protocol (PAP)

The PAP is a relatively straightforward protocol that relies on a name and password being supplied by one side of the connection (as negotiated during LCP). The other side then verifies this information. If correct, an acceptance message is returned to the sender and PPP can then proceed to the IPCP state machine. Otherwise, if either the name or password is incorrect, the connection is rejected.

Note that both sides of the interface can request PAP, but PAP is typically used in only one direction.

Challenge-Handshake Authentication Protocol (CHAP)

The CHAP is a more complex authentication protocol than PAP. The CHAP authenticator supplies its peer with a name and a value. The peer then uses the supplied name to find a shared “secret” between the two entities. A computation is then done over the ID, value, and the “secret.” The result of this computation is returned in the response. If correct, PPP can then proceed to the IPCP state machine. Otherwise, if the result is incorrect, the connection is rejected.

Another interesting aspect of CHAP is that it can occur at random intervals after a connection has been established. This is used to prevent a connection from being hijacked – after it has been authenticated. If a challenge fails at one of these random times, the connection is immediately terminated.

Note that both sides of the interface can request CHAP, but CHAP is typically used in only one direction.

Internet Protocol Control Protocol (IPCP)

The IPCP is the last protocol to execute before the PPP communication is available for NetX IP data transfer. The main purpose of this protocol is for one peer to inform the other of its IP address. Once the IP address is setup, NetX IP data transfer is enabled.

Data Transfer

As mentioned previously, NetX IP data packets reside in PPP frames with a protocol ID of 0x0021. All received data packets are placed in one or more NX_PACKET structures and transferred to the NetX receive processing. On transmission, the NetX packet contents are placed in an AHDLC frame and transmitted.

PPP RFCs

NetX PPP is compliant with RFC1332, RFC1334, RFC1661, RFC1994, and related RFCs.

Chapter 2

Installation and Use of PPP

This chapter contains a description of various issues related to installation, setup, and usage of the NetX PPP component.

Product Distribution

PPP for NetX is shipped on a single CD-ROM compatible disk. The package includes two source files and a PDF file that contains this document, as follows:

nx_ppp.h	Header file for PPP for NetX
nx_ppp.c	C Source file for PPP for NetX
nx_ppp.pdf	PDF description of PPP for NetX
demo_netx_ppp.c	NetX PPP demonstration

PPP Installation

In order to use PPP for NetX, the entire distribution mentioned previously should be copied to the same directory where NetX is installed. For example, if NetX is installed in the directory "*threadx**arm7**green*" then the *nx_ppp.h* and *nx_ppp.c* files should be copied into this directory.

Using PPP

Using PPP for NetX is easy. Basically, the application code must include *nx_ppp.h* after it includes *tx_api.h* and *nx_api.h*, in order to use ThreadX and NetX, respectively. Once *nx_ppp.h* is included, the application code is then able to make the PPP function calls specified later in this guide. The application must also include *nx_ppp.c* in the build process. This file must be compiled in the same manner as other application files and its object form must be linked along with the files of the application. This is all that is required to use NetX PPP.

Using Modems

If a modem is required for connection to the internet, some special considerations are required in order to use the NetX PPP product. Basically, using a modem introduces additional initialization logic and logic for loss of communication. In addition, most of the additional modem logic

is done outside the context of NetX PPP. The basic flow of using the NetX PPP with a modem goes something like this:

1. Initialize Modem
2. Dial Internet Service Provider (ISP)
3. Wait for Connection
4. Wait for UserID Prompt
5. Start NetX PPP

[PPP in operation]

6. Loss of Communication
7. Stop NetX PPP (or restart via nx_ppp_restart)

Initialize Modem

Using the application's low-level serial output routine, the modem is initialized via a series of ASCII character commands (see modem's documentation for more details).

Dial Internet Service Provider

Using the application's low-level serial output routine, the modem is instructed to dial the ISP. For example, the following is typical of an ASCII string used to dial an ISP at the number 123-4567:

"ATDT123456\r"

Wait for Connection

At this point, the application waits to receive indication from the modem that a connection has been established. This is accomplished by looking for characters from the application's low-level serial input routine. Typically, modems return an ASCII string "CONNECT" when a connection has been established.

Wait for User ID Prompt

Once the connection has been established, the application must now wait for an initial login request from the ISP. This typically takes the form of an ASCII string like “Login?”

Start NetX PPP

At this point, the NetX PPP can be started. This is accomplished by calling the *nx_ppp_create* service followed by the *nx_ip_create* service. Additional services to enable PAP and to setup the PPP IP addresses might also be required. Please review the following sections of this guide for more information.

Loss of Communication

Once PPP is started, any non-PPP information is passed to the “invalid packet handling” routine the application specified to the *nx_ppp_create* service. Typically, modems send an ASCII string such as “NO CARRIER” when communication is lost with the ISP. When the application receives a non-PPP packet with such information, it should proceed to either stop the NetX PPP instance or to restart the PPP state machine via the *nx_ppp_restart* API.

Stop NetX PPP

Stopping the NetX PPP is fairly straightforward. Basically, all created sockets must be unbound and deleted. Next, delete the IP instance via the *nx_ip_delete* service. Once the IP instance is deleted, the *nx_ppp_delete* service should be called to finish the process of stopping PPP. At this point, the application is now able to attempt to reestablish communication with the ISP.

Small Example System

An example that illustrates how easy it is to use NetX PPP is described in Figure 1.1 that appears below. In this example, the PPP include file *nx_ppp.h* is brought in at line 3. Next, PPP is created in*"tx_application_define*" at line 56. The PPP control block "*my_ppp*" was defined as a global variable at line 9 previously. Note that PPP should be created prior to creating the IP instance. After successful creation of PPP and IP, the thread "*my_thread*" waits for the PPP link to come alive at line 98. At line 104, both PPP and NetX are fully operational.

The one item not shown in this example is the application's serial byte receive ISR. It will need to call *nx_ppp_byte_receive* with "*my_ppp*" and the byte received as input parameters.

```
0001 #include   "tx_api.h"
0002 #include   "nx_api.h"
0003 #include   "nx_ppp.h"
0004
0005 #define     DEMO_STACK_SIZE         4096
0006 TX_THREAD               my_thread;
0007 NX_PACKET_POOL          my_pool;
0008 NX_IP                   my_ip;
0009 NX_PPP                  my_ppp;
0010
0011 /* Define function prototypes. */
0012
0013 void    my_thread_entry(ULONG thread_input);
0014 void    my_serial_driver_byte_output(UCHAR byte);
0015 void    my_invalid_packet_handler(NX_PACKET *packet_ptr);
0016
0017 /* Define main entry point. */
0018 intmain()
0019 {
0020
0021     /* Enter the ThreadX kernel. */
0022     tx_kernel_enter();
0023 }
0024
0025
0026 /* Define what the initial system looks like. */
0027
0028 void    tx_application_define(void *first_unused_memory)
0029 {
0030
0031 CHAR    *pointer;
0032 UINT    status;
0033
0034
0035     /* Setup the working pointer. */
0036     pointer =  (CHAR *) first_unused_memory;
0037
0038     /* Create "my_thread". */
0039   tx_thread_create(&my_thread, "my thread", my_thread_entry, 0,
0040                    pointer, DEMO_STACK_SIZE,
0041                    2, 2, TX_NO_TIME_SLICE, TX_AUTO_START);
0042     pointer =  pointer + DEMO_STACK_SIZE;
0043
0044     /* Initialize the NetX system. */
0045     nx_system_initialize();
0046
0047     /* Create a packet pool. */
0048     status =  nx_packet_pool_create(&my_pool, "NetX Main Packet Pool",
0049                                     1024, pointer, 64000);
0050     pointer = pointer + 64000;
0051
0052     /* Check for pool creation error. */
0053     if (status)
0054         error_counter++;
```

```
0055
0055     /* Create a PPP instance. */
0056     status = nx_ppp_create(&my_ppp, “My PPP”, &my_ip, pointer, 1024, 2,
0057           &my_pool, my_invalid_packet_handler, my_serial_driver_byte_output);
0058     pointer =  pointer + 1024;
0059     /* Check for PPP creation pool. */
0060     if (status)
0061         error_counter++;
0062
0063     /* Create an IP instance with the PPP driver. */
0064     status = nx_ip_create(&my_ip,"My NetX IP Instance",
0065             IP_ADDRESS(216,2,3,1), 0xFFFFFF00, &my_pool,
0066             nx_ppp_driver, pointer, DEMO_STACK_SIZE, 1);
0067     pointer =  pointer + DEMO_STACK_SIZE;
0068
0069     /* Check for IP create errors. */
0070     if (status)
0071         error_counter++;
0072
0073     /* Enable ICMP for my IP Instance. */
0074     status =  nx_icmp_enable(&my_ip);
0075
0076     /* Check for ICMP enable errors. */
0077     if (status)
0078         error_counter++;
0079
0080     /* Enable UDP. */
0081     status =  nx_udp_enable(&my_ip);
0082     if (status)
0083         error_counter++;
0084 }
0085
0086
0087 /* Define my thread. */
0088
0089 void    my_thread_entry(ULONG thread_input)
0090 {
0091
0092 UINT        status;
0093 ULONG       ip_status;
0094 NX_PACKET   *my_packet;
0095
0096
0097     /* Wait for the PPP link in my_ip to become enabled. */
0098     status =  nx_ip_status_check(&my_ip,NX_IP_LINK_ENABLED,&ip_status,3000);
0099
0100     /* Check for IP status error. */
0101     if (status)
0102        return;
0103
0104     /* Link is fully up and operational. All NetX activities
0105        are now available. */
0106
0107 }
```

Figure 1.1 Example of PPP use with NetX

Configuration Options

There are several configuration options for building PPP for NetX. The following list describes each in detail:

Define	Meaning
NX_DISABLE_ERROR_CHECKING	Defined, this option removes the basic PPP error checking. It is typically used after the application has been debugged.
NX_PPP_PPPOE_ENABLE	If defined, PPP can transmit packet over Ethernet
NX_PPP_BASE_TIMEOUT	This defines the period rate (in timer ticks) that the PPP thread task is woken to check for PPP events. The default value is 1*NX_IP_PERIODIC_RATE (100 ticks).
NX_PPP_DISABLE_INFO	If defined, internal PPP information gathering is disabled.
NX_PPP_DEBUG_LOG_ENABLE	If defined, internal PPP debug log is enabled.
NX_PPP_DEBUG_LOG_PRINT_ENABLE	If defined, internal PPP debug log *printf* to *stdio* is enabled. This is only valid if the debug log is also enabled.
NX_PPP_DEBUG_LOG_SIZE	Size of debug log (number of entries in the debug log). On reaching the last entry, the debug capture wraps to the first entry and overwrites any data previously captured. The default value is 50.
NX_PPP_DEBUG_FRAME_SIZE	Maximum amount of data captured from a received packet payload and saved to debug output. The default value is 50.

NX_PPP_DISABLE_CHAP If defined, internal PPP CHAP logic is removed, including the MD5 digest logic.

NX_PPP_DISABLE_PAP If defined, internal PPP PAP logic is removed.

NX_PPP_DNS_OPTION_DISABLE If defined, the primary DNS Server Option is disabled in the IPCP response. By default this option is not defined.

NX_PPP_DNS_ADDRESS_MAX_RETRIES
This specifies how many times the PPP host will request a DNS Server address from the peer in the IPCP state. This has no effect if NX_PPP_DNS_OPTION_DISABLE is defined. The default value is 2.

NX_PPP_SECONDARY_DNS_OPTION_DISABLE
If defined, the Secondary DNS Server Option is disabled in the IPCP response. By default this option is not defined.

NX_PPP_SECONDARY_DNS_ADDRESS_MAX_RETRIES
This specifies how many times the PPP host will request a Secondary DNS Server address from the peer in the IPCP state. This has no effect if NX_PPP_SECONDARY_DNS_OPTION_DISABLE is defined. The default value is 2.

NX_PPP_HASHED_VALUE_SIZE Specifies the size of “hashed value” strings used in CHAP authentication. The default value is set to 16 bytes, but can be redefined prior to inclusion of *nx_ppp.h.*

NX_PPP_MAX_LCP_PROTOCOL_RETRIES

This defines the max number of retries if the PPP times out before sending another LCP configure request message. When this number is reached the PPP handshake is aborted and the link status is down. The default value is 20.

NX_PPP_MAX_PAP_PROTOCOL_RETRIES

This defines the max number of retries if the PPP times out before sending another PAP authentication request message. When this number is reached the PPP handshake is aborted and the link status is down. The default value is 20.

NX_PPP_MAX_CHAP_PROTOCOL_RETRIES

This defines the max number of retries if the PPP times out before sending another CHAP challenge message. When this number is reached the PPP handshake is aborted and the link status is down. The default value is 20.

NX_PPP_MAX_IPCP_PROTOCOL_RETRIES

This defines the max number of retries if the PPP times out before sending another IPCP configure request message. When this number is reached the PPP handshake is aborted and the link status is down. The default value is 20.

NX_PPP_MRU

Specifies the Maximum Receive Unit (MRU) for PPP. By default, this value is 1,500 bytes (the minimum value). This define can be set by the application prior to inclusion of *nx_ppp.h*.

NX_PPP_MINIMUM_MRU	Specifies the minimum MRU received in an LCP configure request message. By default, this value is 1,500 bytes (the minimum value). This define can be set by the application prior to inclusion of *nx_ppp.h*.
NX_PPP_NAME_SIZE	Specifies the size of “name” strings used in authentication. The default value is set to 32bytes, but can be redefined prior to inclusion of *nx_ppp.h.*
NX_PPP_PASSWORD_SIZE	Specifies the size of “password” strings used in authentication. The default value is set to 32bytes, but can be redefined prior to inclusion of *nx_ppp.h.*
NX_PPP_PROTOCOL_TIMEOUT	This defines the wait option (in seconds) for the PPP task to receive a response to a PPP protocol request message. The default value is 4 seconds.
NX_PPP_RECEIVE_TIMEOUTS	This defines the number of times the PPP thread task times out waiting to receive the next character in a PPP message stream. Thereafter, PPP releases the packet and begins waiting to receive the next PPP message. The default value is 4.
NX_PPP_SERIAL_BUFFER_SIZE	Specifies the size of the receive character serial buffer. By default, this value is 3,000 bytes. This define can be set by the application prior to inclusion of *nx_ppp.h*.
NX_PPP_TIMEOUT	This defines the wait option (in

	timer ticks) for allocating packets to transmit data as well as buffer PPP serial data into packets to send to the IP layer. The default value is 4*NX_IP_PERIODIC_RATE (400 ticks).
NX_PPP_THREAD_TIME_SLICE	Time-slice option for PPP threads. By default, this value is TX_NO_TIME_SLICE. This define can be set by the application prior to inclusion of *nx_ppp.h*.
NX_PPP_VALUE_SIZE	Specifies the size of “value” strings used in CHAP authentication. The default value is set to 32bytes, but can be redefined prior to inclusion of *nx_ppp.h.*

Chapter 3

Description of PPP Services

This chapter contains a description of all NetX PPP services (listed below) in alphabetic order.

In the “Return Values” section in the following API descriptions, values in **BOLD** are not affected by the **NX_DISABLE_ERROR_CHECKING** define that is used to disable API error checking, while non-bold values are completely disabled.

nx_ppp_byte_receive
Receive a byte from serial ISR

nx_ppp_chap_challenge
Generate a CHAP challenge

nx_ppp_chap_enable
Enable CHAP authentication

nx_ppp_create
Create a PPP instance

nx_ppp_delete
Delete a PPP instance

nx_ppp_dns_address_get
Get DNS Server IP address

nx_ppp_dns_address_set
Set DNS Server IP address

nx_ppp_secondary_dns_address_get
Get Secondary DNS Server IP address

nx_ppp_secondary_dns_address_set
Set Secondary_DNS Server IP address

nx_ppp_interface_index_get
Get IP interface index

nx_ppp_ip_address_assign
Assign IP addresses for IPCP

nx_ppp_link_down_notify
Notify application on link down

nx_ppp_link_up_notify
Notify application on link up

nx_ppp_nak_authentication_notify
Notify application if authentication NAK is received

nx_ppp_pap_enable
Enable PAP authentication

nx_ppp_ping_request
Send an LCP echo request

nx_ppp_raw_string_send
Send non PPP string

nx_ppp_restart
Restart PPP processing

nx_ppp_status_get
Get current PPP status

nx_ppp_packet_receive
Receive PPP packet

nx_ppp_packet_send_set
Set PPP packet send function

nx_ppp_byte_receive

Receive a byte from serial ISR

Prototype

```
UINT nx_ppp_byte_receive(NX_PPP *ppp_ptr, UCHAR byte);
```

Description

This service is typically called from the application's serial driver Interrupt Service Routine (ISR) to transfer a received byte to PPP. When called, this routine places the received byte into a circular byte buffer and notifies the appropriate PPP thread for processing.

Input Parameters

ppp_ptr	Pointer to PPP control block.
byte	Byte received from serial device

Return Values

NX_SUCCESS	(0x00)	Successful PPP byte receive.
NX_PPP_BUFFER_FULL	(0xB1)	PPP serial buffer is already full.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Threads, ISRs

Example

```
/* Notify "my_ppp" of a received byte. */
status =  nx_ppp_byte_receive(&my_ppp, new_byte);

/* If status is NX_SUCCESS the received byte was successfully
   buffered. */
```

nx_ppp_chap_challenge

Generate a CHAP challenge

Prototype

```
UINT nx_ppp_chap_challenge(NX_PPP *ppp_ptr);
```

Description

This service initiates a CHAP challenge after the PPP connection is already up and running. This gives the application the ability to verify the authenticity of the connection on a periodic basis. If the challenge is unsuccessful, the PPP link is closed.

Input Parameters

ppp_ptr Pointer to PPP control block.

Return Values

NX_SUCCESS	(0x00)	Successful PPP challenge initiated.
NX_PPP_FAILURE	(0xB0)	Invalid PPP challenge, CHAP was enabled only for response.
NX_NOT_IMPLEMENTED	(0x80)	CHAP logic was disabled via NX_PPP_DISABLE_CHAP.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Threads

Example

```
/* Initiate a PPP challenge for instance “my_ppp”. */
status =  nx_ppp_chap_challenge(&my_ppp);

/* If status is NX_SUCCESS a CHAP challenge “my_ppp” was successfully
initiated. */
```

nx_ppp_chap_enable

Enable CHAP authentication

Prototype

```
UINT nx_ppp_chap_enable(NX_PPP *ppp_ptr,
 UINT (*get_challenge_values)(CHAR *rand_value,CHAR *id,CHAR *name),
 UINT (*get_responder_values)(CHAR *system,CHAR *name,CHAR *secret),
 UINT (*get_verification_values)(CHAR *system,CHAR
                                 *name,CHAR *secret));
```

Description

This service enables the Challenge-Handshake Authentication Protocol (CHAP) for the specified PPP instance.

If the "***get_challenge_values***" and "***get_verification_values***" function pointers are specified, CHAP is required by this PPP instance. Otherwise, CHAP only responds to the peer's challenge requests.

There are several data items referenced below in the required callback functions. The data items *secret*, *name*, and *system* are expected to be NULL-terminated strings with a maximum size of NX_PPP_NAME_SIZE-1. The data item *rand_value* is expected to be a NULL-terminated string with a maximum size of NX_PPP_VALUE_SIZE-1. The data item *id* is a simple unsigned character type.

Note that this function must be called after *nx_ppp_create* but before nx_ip_create or *nx_ip_interface_attach*.

Input Parameters

ppp_ptr	Pointer to PPP control block.
get_challenge_values	Pointer to application function to retrieve values used for the challenge. Note that the *rand_value*, *id*, and *secret* values must be copied into the supplied destinations.
get_responder_values	Pointer to application function that retrieves values used to respond to a challenge. Note that the *system*, *name*, and *secret* values must be copied into the supplied destinations.
get_verification_values	Pointer to application function that retrieves values used to verify the challenge response. Note that the *system*,*name*, and *secret* values must be copied into the supplied destinations.

Return Values

NX_SUCCESS	(0x00)	Successful PPP CHAP enable
NX_NOT_IMPLEMENTED	(0x80)	CHAP logic was disabled via NX_PPP_DISABLE_CHAP.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer or callback function pointer. Note that if *get_challenge_values* is specified, then the *get_verification_values* function must also be supplied.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Initialization, threads

Example

```
CHAR    name_string[] = "username";
CHAR    rand_value_string[] = "123456";
CHAR    system_string[] = "system";
CHAR    secret_string[] = "secret";

/* Enable CHAP in both directions (CHAP challenger and CHAP responder) for
“my_ppp”. */
status =  nx_ppp_chap_enable(&my_ppp, get_challenge_values,
                                      get_responder_values,
                                      get_verification_values);


/* If status is NX_SUCCESS, “my_ppp” has CHAP enabled. */

…

/* Define the CHAP enable routines.  */
UINT  get_challenge_values(CHAR *rand_value, CHAR *id, CHAR *name)
{

UINT    i;

        for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
        {
                name[i] = name_string[i];
        }
        name[i] =  0;


        *id =  '1';  /* One byte  */

        for (i = 0; i< (NX_PPP_VALUE_SIZE-1); i++)
        {
                rand_value[i] =  rand_value_string[i];
        }
        rand_value[i] =  0;


        return(NX_SUCCESS);
}


UINT  get_responder_values(CHAR *system, CHAR *name, CHAR *secret)
{


UINT    i;
```

```
        for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
        {
                name[i] = name_string[i];
        }
        name[i] =  0;


        for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
        {
                system[i] =  system_string[i];
        }
        system[i] =  0;


        for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
        {
                secret[i] =  secret_string[i];
        }
        secret[i] =  0;

        return(NX_SUCCESS);
}

UINT  get_verification_values(CHAR *system, CHAR *name, CHAR *secret)
{

UINT    i;

        for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
        {
                name[i] = name_string[i];
        }
        name[i] =  0;


        for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
        {
                system[i] =  system_string[i];
        }
        system[i] =  0;


        for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
        {
                secret[i] =  secret_string[i];
        }
        secret[i] =  0;

        return(NX_SUCCESS);
}
```

nx_ppp_create

Create a PPP instance

Prototype

```
UINT  nx_ppp_create(NX_PPP *ppp_ptr, CHAR *name, NX_IP *ip_ptr,
      VOID *stack_memory_ptr, ULONG stack_size,
            UINT thread_priority, NX_PACKET_POOL *pool_ptr,
            void (*ppp_invalid_packet_handler)(NX_PACKET *packet_ptr)),
            void (*ppp_byte_send)(UCHAR byte));
```

Description

This service creates a PPP instance for the specified NetX IP instance. This function must be called prior to creating the NetX IP instance.

Note that it is generally a good idea to create the NetX IP thread at a higher priority than the PPP thread priority. Please refer to the *nx_ip_create* service for more information on specifying the IP thread priority.

Input Parameters

ppp_ptr	Pointer to PPP control block.
name	Name of this PPP instance.
ip_ptr	Pointer to control block for not-yet-created IP instance.
stack_memory_ptr	Pointer to start of PPP thread's stack area.
stack_size	Size in bytes in the thread's stack.
pool_ptr	Pointer to default packet pool.
thread_priority	Priority of internal PPP threads (1-31).
ppp_invalid_packet_handler	Function pointer to application's handler for all non-PPP packets. The NetX PPP typically calls this routine during initialization. This is where the application can respond to modem commands or in the case of Windows XP, the NetX PPP application can initiate PPP by responding with" CLIENT SERVER" to the initial "CLIENT" sent by Windows XP.
ppp_byte_send	Function pointer to application's serial byte output routine.

Return Values

NX_SUCCESS	(0x00)	Successful PPP create.
NX_PTR_ERROR	(0x07)	Invalid PPP, IP, or byte output function pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Initialization, threads

Example

```
/* Create “my_ppp” for IP instance “my_ip”. */
status =  nx_ppp_create(&my_ppp, “my PPP”, &my_ip, stack_start, 1024, 2,
                        &my_pool, my_invalid_packet_handler, my_out_byte);

/* If status is NX_SUCCESS the PPP instance was successfully
   created. */
```

nx_ppp_delete

Delete a PPP instance

Prototype

```
UINT nx_ppp_delete(NX_PPP *ppp_ptr);
```

Description

This service deletes the previously created PPP instance.

Input Parameters

ppp_ptr	Pointer to PPP control block.

Return Values

NX_SUCCESS	(0x00)	Successful PPP deletion.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Threads

Example

```
/* Delete PPP instance “my_ppp”. */
status =  nx_ppp_delete(&my_ppp);

/* If status is NX_SUCCESS the “my_ppp” was successfully deleted. */
```

nx_ppp_dns_address_get

Get DNS Server IP address

Prototype

```
UINT nx_ppp_dns_address_get(NX_PPP *ppp_ptr, ULONG *dns_address_ptr);
```

Description

This service retrieves the DNS IP address supplied by the peer in the IPCP handshake. If no IP address was supplied by the peer, an IP address of 0 is returned.

Input Parameters

ppp_ptr	Pointer to PPP control block.
dns_address_ptr	Destination for DNS server address

Return Values

NX_SUCCESS	(0x00)	Successful DNS address get
NX_PPP_NOT_ESTABLISHED	(0xB5)	PPP has not completed negotiation with peer.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads, timers, ISRs

Example

```
ULONG  my_dns_address;

/* Get DNS Server address supplied by peer. */
status =  nx_ppp_dns_address_get(&my_ppp, &my_dns_address);

/* If status is NX_SUCCESS the “my_dns_address” contains the DNS IP address –
   if the peer supplied one. */
```

nx_ppp_secondary_dns_address_get

Get Secondary DNS Server IP address

Prototype

```
UINT nx_ppp_secondary_dns_address_get(NX_PPP *ppp_ptr, ULONG
*dns_address_ptr);
```

Description

This service retrieves the secondary DNS IP address supplied by the peer in the IPCP handshake. If no IP address was supplied by the peer, an IP address of 0 is returned.

Input Parameters

ppp_ptr	Pointer to PPP control block.
dns_address_ptr	Destination for Secondary DNS server address

Return Values

NX_SUCCESS	(0x00)	Successful DNS address get
NX_PPP_NOT_ESTABLISHED	(0xB5)	PPP has not completed negotiation with peer.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads, timers, ISRs

Example

```
ULONG  my_dns_address;

/* Get secondary DNS Server address supplied by peer. */
status =  nx_ppp_secondary_dns_address_get(&my_ppp, &my_dns_address);

/* If status is NX_SUCCESS the “my_dns_address” contains the secondary DNS Server
address – if the peer supplied one. */
```

nx_ppp_dns_address_set

Set primary DNS Server IP address

Prototype

```
UINT nx_ppp_dns_address_set(NX_PPP *ppp_ptr, ULONG dns_address);
```

Description

This service sets the DNS Server IP address. If the peer sends a DNS Server option request in the IPCP state, this host will provide the information.

Input Parameters

ppp_ptr	Pointer to PPP control block.
dns_address	DNS server address

Return Values

NX_SUCCESS	(0x00)	Successful DNS address set
NX_PPP_NOT_ESTABLISHED	(0xB5)	PPP has not completed negotiation with peer.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads

Example

```
ULONG  my_dns_address = IP_ADDRESS(1,2,3,1);

/* Set DNS Server address. */
status =  nx_ppp_dns_address_set(&my_ppp, my_dns_address);

/* If status is NX_SUCCESS the “my_dns_address” will be the DNS Server address
provided if the peer requests one. */
```

nx_ppp_secondary_dns_address_set

Set secondary DNS Server IP address

Prototype

```
UINT nx_ppp_secondary_dns_address_set(NX_PPP *ppp_ptr, ULONG
dns_address);
```

Description

This service sets the secondary DNS Server IP address. If the peer sends a secondary DNS Server option request in the IPCP state, this host will provide the information.

Input Parameters

ppp_ptr	Pointer to PPP control block.
dns_address	Secondary DNS server address

Return Values

NX_SUCCESS	(0x00)	Successful DNS address set
NX_PPP_NOT_ESTABLISHED	(0xB5)	PPP has not completed negotiation with peer.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads

Example

```
ULONG  my_dns_address = IP_ADDRESS(1,2,3,1);

/* Set DNS Server address. */
status =  nx_ppp_secondary_dns_address_set(&my_ppp, my_dns_address);

/* If status is NX_SUCCESS the “my_dns_address” will be the secondary DNS Server
address provided if the peer requests one. */
```

nx_ppp_interface_index_get

Get IP interface index

Prototype

```
UINT nx_ppp_interface_index_get(NX_PPP *ppp_ptr, UINT *index_ptr);
```

Description

This service retrieves the IP interface index associated with this PPP instance. This is only useful when the PPP instance is not the primary interface of an IP instance.

Input Parameters

ppp_ptr	Pointer to PPP control block.
index_ptr	Destination for interface index

Return Values

NX_SUCCESS	(0x00)	Successful PPP index get.
NX_IN_PROGRESS	(0x37)	PPP has not completed initialization.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads

Example

```
ULONG  my_index;

/* Get the interface index for this PPP instance. */
status =  nx_ppp_interface_index_get(&my_ppp, &my_index);

/* If status is NX_SUCCESS the “my_index” contains the IP interface index for
   this PPP instance. */
```

nx_ppp_ip_address_assign

Assign IP addresses for IPCP

Prototype

```
UINT nx_ppp_ip_address_assign(NX_PPP *ppp_ptr, ULONG local_ip_address,
            ULONG peer_ip_address);
```

Description

This service sets up the local and peer IP addresses for use in the Internet Protocol Control Protocol (IPCP. It should be called for the PPP instance that has valid IP addresses for itself and the other peer.

Input Parameters

ppp_ptr	Pointer to PPP control block.
local_ip_address	Local IP address
peer_ip_address	Peer's IP address

Return Values

NX_SUCCESS	(0x00)	Successful PPP address assignment.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Initialization, threads

Example

```
/* Set IP addresses for "my_ppp". */
status =  nx_ppp_ip_address_assign(&my_ppp, IP_ADDRESS(256,2,2,187),
                                           IP_ADDRESS(256,2,2,188));

/* If status is NX_SUCCESS the "my_ppp" has the IP addresses. */
```

nx_ppp_link_down_notify

Notify application on link down

Prototype

```
UINT nx_ppp_link_down_notify(NX_PPP *ppp_ptr,
            VOID (*link_down_callback)(NX_PPP *ppp_ptr));
```

Description

This service registers the application's link down notification callback with the specified PPP instance. If non-NULL, the application's link down callback function is called whenever the link goes down.

Input Parameters

ppp_ptr	Pointer to PPP control block.
link_down_callback	Application's link down notification function pointer. If NULL, link down notification is disabled**.**

Return Values

NX_SUCCESS	(0x00)	Successful link down notification callback registration.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads, timers, ISRs

Example

```
/* Register "my_link_down_callback" to be called whenever the PPP
   link goes down. */
status =  nx_ppp_link_down_notify(&my_ppp, my_link_down_callback);


/* If status is NX_SUCCESS the function "my_link_down_callback" has been
   registered with this PPP instance. */


….


VOID my_link_down_callback(NX_PPP *ppp_ptr)
{

    /* On link down, simply restart PPP.  */
nx_ppp_restart(ppp_ptr);
}
```

nx_ppp_link_up_notify

Notify application on link up

Prototype

```
UINT nx_ppp_link_up_notify(NX_PPP *ppp_ptr,
            VOID (*link_up_callback)(NX_PPP *ppp_ptr));
```

Description

This service registers the application's link up notification callback with the specified PPP instance. If non-NULL, the application's link up callback function is called whenever the link comes up.

Input Parameters

ppp_ptr	Pointer to PPP control block.
link_up_callback	Application's link up notification function pointer. If NULL, link up notification is disabled**.**

Return Values

NX_SUCCESS	(0x00)	Successful link up notification callback registration.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads, timers, ISRs

Example

```
/* Register "my_link_up_callback" to be called whenever the PPP
   link comes up. */
status =  nx_ppp_link_up_notify(&my_ppp, my_link_up_callback);

/* If status is NX_SUCCESS the function "my_link_up_callback" has been
   registered with this PPP instance. */

….

VOID my_link_up_callback(NX_PPP *ppp_ptr)
{

    /* On link up, the application my want to start sending/receiving
       UPD/TCP data.  */
}
```

nx_ppp_nak_authentication_notify

Notify application if authentication NAK received

Prototype

```
UINT    nx_ppp_nak_authentication_notify(NX_PPP *ppp_ptr,
                    void (*nak_authentication_notify)(void));
```

Description

This service registers the application's authentication nak notification callback with the specified PPP instance. If non-NULL, this callback function is called whenever the PPP instance receives a NAK during authentiaction.

Input Parameters

ppp_ptr Pointer to PPP control block.

nak_authentication_notify
Pointer to function called when the PPP instance receives an authentication NAK. If NULL, the notification is disabled**.**

Return Values

NX_SUCCESS	(0x00)	Successful notification callback registration.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads, timers, ISRs

Example

```
/* Register "my_nak_auth_callback" to be called whenever the PPP
   receives a NAK during authentication. */
status =  nx_ppp_nak_authentication_notify(&my_ppp, my_nak_auth_callback);


/* If status is NX_SUCCESS the function "my_nak_auth_callback" has been
   registered with this PPP instance. */


VOID my_nak_auth_callback(NX_PPP *ppp_ptr)
{

    /* Handle the situation of receiving an authentication NAK */
}
```

nx_ppp_pap_enable

Enable PAP Authentication

Prototype

```
UINT  nx_ppp_pap_enable(NX_PPP *ppp_ptr,
      UINT (*generate_login)(CHAR *name, CHAR *password),
      UINT (*verify_login)(CHAR *name, CHAR *password));
```

Description

This service enables the Password Authentication Protocol (PAP) for the specified PPP instance. If the "***verify_login***" function pointer is specified, PAP is required by this PPP instance. Otherwise, PAP only responds to the peer's PAP requirements as specified during LCP negotiation.

There are several data items referenced below in the required callback functions. The data item *name* is expected to be NULL-terminated string with a maximum size of NX_PPP_NAME_SIZE-1. The data item *password* is also expected to be a NULL-terminated string with a maximum size of NX_PPP_PASSWORD_SIZE-1.

Note that this function must be called after *nx_ppp_create* but before *nx_ip_create* or *nx_ip_interface_attach*.

Input Parameters

ppp_ptr	Pointer to PPP control block.
generate_login	Pointer to application function that produces a *name* and *password* for authentication by the peer. Note that the *name* and *password* values must be copied into the supplied destinations.
verify_login	Pointer to application function that verifies the *name* and *password* supplied by the peer. This routine must compare the supplied *name* and *password*. If this routine returns NX_SUCCESS, the name and password are correct and PPP can proceed to the next step. Otherwise, this routine returns NX_PPP_ERROR and PPP simply waits for another name and password.

Return Values

NX_SUCCESS	(0x00)	Successful PPP PAP enable.
NX_NOT_IMPLEMENTED	(0x80)	PAP logic was disabled via NX_PPP_DISABLE_PAP.

NX_PTR_ERROR	(0x07)	Invalid PPP pointer or application function pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Initialization, threads

Example

```
CHAR    name_string[] = "username";
CHAR    password_string[] =  "password";


/* Enable PAP for PPP instance “my_ppp”. */
status =  nx_ppp_pap_enable(&my_ppp, my_generate_login, my_verify_login);

/* If status is NX_SUCCESS the “my_ppp” now has PAP enabled. */

…

/* Define callback routines for PAP enable.  */

UINT  generate_login(CHAR *name, CHAR *password)
{

UINT    i;

for (i = 0; i< (NX_PPP_NAME_SIZE-1); i++)
name[i] = name_string[i];
name[i] =  0;

for (i = 0; i< (NX_PPP_PASSWORD_SIZE-1); i++)
password[i] = password_string[i];
password_string[i] =  0;

return(NX_SUCCESS);
}

UINT  verify_login(CHAR *name, CHAR *password)
{

    /* Assume name and password are correct. Normally,
a comparison would be made here!  */
printf("Name: %s, Password: %s\n", name, password);

return(NX_SUCCESS);
}
```

nx_ppp_ping_request

Send an LCP ping request

Prototype

```
UINT  nx_ppp_ping_request(NX_PPP *ppp_ptr, CHAR *data, UINT data_size,
                          ULONG wait_opion);
```

Description

This service sends an LCP request and sets a flag that the PPP device is waiting for an echo response. The wait option is primarily for the *nx_packet_allocate* call. The service returns as soon as the request is sent. It does not wait for a response.

When a matching echo response is received, the PPP thread task will clear the flag. The PPP device must have completed the LCP part of the PPP negotiation.

This service is useful for PPP set ups where polling the hardware for link status may not be readily possible.

Input Parameters

ppp_ptr	Pointer to PPP control block.
data	Pointer to data to send in echo request.
data_size	Size of data to send
wait_option	Time to wait to send the LCP echo message.

Return Values

NX_SUCCESS	(0x00)	Successful sent echo request.
NX_PPP_NOT_ESTABLISHED	(0xB5)	PPP connection not established.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer or application function pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Application threads

Example

```
CHAR    buffer[] = "username";
UINT    buffer_length =  strlen("username ");


/* Send an LCP ping request". */
status =  nx_ppp_ping_request(&my_ppp, &buffer[0], buffer_length, 200);

/* If status is NX_SUCCESS the LCP echo request was successfully sent. Now wait to
   receive a response. */

while(my_ppp.nx_ppp_lcp_echo_reply_id > 0)
{
        tx_thread_sleep(100);
}

/* Got a valid reply! */
```

nx_ppp_raw_string_send

Send a raw ASCII string

Prototype

```
UINT  nx_ppp_raw_sting_send(NX_PPP *ppp_ptr, CHAR *string_ptr);
```

Description

This service sends a non-PPP ASCII string directly out the PPP interface. It is typically used after PPP receives an non-PPP packet that contains modem control information.

Input Parameters

ppp_ptr	Pointer to PPP control block.
string_ptr	Pointer to string to send.

Return Values

NX_SUCCESS	(0x00)	Successful PPP raw string send.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer or string pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Threads

Example

```
/* Send "CLIENTSERVER" to "CLIENT" sent by Windows 98 before PPP is
initiated.  */
status =  nx_ppp_raw_string_send(&my_ppp, "CLIENTSERVER");

/* If status is NX_SUCCESS the raw string was successfully Sent via PPP. */
```

nx_ppp_restart

Restart PPP processing

Prototype

```
UINT  nx_ppp_restart(NX_PPP *ppp_ptr);
```

Description

This service restarts the PPP processing. It is typically called when the link needs to be re-established either from a link down callback or by a non-PPP modem message indicating communication was lost.

Input Parameters

ppp_ptr	Pointer to PPP control block.

Return Values

NX_SUCCESS	(0x00)	Successful PPP restart initiated.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.
NX_CALLER_ERROR	(0x11)	Invalid caller of this service.

Allowed From

Threads

Example

```
/* Restart the PPP instance “my_ppp”.  */
status =  nx_ppp_restart(&my_ppp);

/* If status is NX_SUCCESS the PPP instance has been restarted. */
```

nx_ppp_status_get

Get current PPP status

Prototype

```
UINT  nx_ppp_status_get(NX_PPP *ppp_ptr, UINT *status_ptr);
```

Description

This service gets the current status of the specified PPP instance.

Input Parameters

ppp_ptr	Pointer to PPP control block.
status_ptr	Destination for the PPP status, the following are possible status values: **NX_PPP_STATUS_ESTABLISHED** **NX_PPP_STATUS_LCP_IN_PROGRESS** **NX_PPP_STATUS_LCP_FAILED** **NX_PPP_STATUS_PAP_IN_PROGRESS** **NX_PPP_STATUS_PAP_FAILED** **NX_PPP_STATUS_CHAP_IN_PROGRESS** **NX_PPP_STATUS_CHAP_FAILED** **NX_PPP_STATUS_IPCP_IN_PROGRESS** **NX_PPP_STATUS_IPCP_FAILED** Note that the status is only valid if the API returns NX_SUCCESS. In addition, if any of the *_FAILED status values are returned, PPP processing is effectively stopped until it is restarted again by the application.

Return Values

NX_SUCCESS	(0x00)	Successful PPP status request.

NX_PTR_ERROR (0x07) Invalid PPP pointer.

Allowed From

Initialization, threads, timers, ISRs

Example

```
UINT ppp_status;
UINT status;


/* Get the current status of PPP instance “my_ppp”.  */
status =  nx_ppp_status_get(&my_ppp, &ppp_status);

/* If status is NX_SUCCESS the current internal PPP status is contained in
   “ppp_status”. */
```

nx_ppp_packet_receive

Receive PPP packet

Prototype

```
UINT  nx_ppp_packet_receive(NX_PPP *ppp_ptr, NX_PACKET *packet_ptr);
```

Description

This service receives PPP packet.

Input Parameters

ppp_ptr	Pointer to PPP control block.
packet_ptr	Pointer to PPP packet.

Return Values

NX_SUCCESS	(0x00)	Successful PPP status request.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads

Example

```
/* Receive the PPP packet of PPP instance “my_ppp”.  */
status =  nx_ppp_packet_receive(&my_ppp, packet_ptr);

/* If status is NX_SUCCESS the PPP packet has received. */
```

nx_ppp_packet_send_set

Set the PPP packet send function

Prototype

```
UINT  nx_ppp_packet_send_set(NX_PPP *ppp_ptr,
                             VOID (*nx_ppp_packet_send)(NX_PACKET *packet_ptr));
```

Description

This service sets the PPP packet send funciton.

Input Parameters

ppp_ptr	Pointer to PPP control block.
nx_ppp_packet_send	Routine to send PPP packet.

Return Values

NX_SUCCESS	(0x00)	Successful PPP status request.
NX_PTR_ERROR	(0x07)	Invalid PPP pointer.

Allowed From

Initialization, threads

Example

```
/* Set the PPP packet send function of PPP instance "my_ppp".  */
status =  nx_ppp_packet_send_set(&my_ppp, nx_ppp_packet_send);

/* If status is NX_SUCCESS the PPP packet send function has set. */
```