Renesas Synergy™ Platform

NetX™ DHCP Client Module Guide

Introduction

This module guide will enable you to effectively use a module in your own design. Upon completion of this guide, you will be able to add this module to your own design, configure it correctly for the target application and write code, using the included application project code as a reference and efficient starting point. References to more detailed API descriptions and suggestions of other application projects that demonstrate more advanced uses of the module are available in the Renesas Synergy™ Knowledge Base (as described in the References Section at the end of this document) and should be valuable resources for creating more complex designs.

The Dynamic Host Configuration Protocol (DHCP) is an extremely useful protocol to obtain an IP address and network parameters. The DHCP is designed to extend the basic functionality of the BOOTP (which is limited to static address configuration) to include a completely dynamic IP address allocation through **leasing** an IP address to a client for a specified period of time. The DHCP can also be configured to allocate IP addresses in a static manner, like the BOOTP. An application's IP address is one of the supplied parameters for the NetX™ component. Supplying the IP address poses no problem if the IP address is known to the application, either statically or through the user configuration. When the application does not know or care what its IP address is, the NetX is initialized with a zero IP address; a DHCP client component added to NetX can then obtain an IP address.

This document provides an overview of the key elements related to the NetX DHCP Client module implementation on the Renesas Synergy Platform. This document's primary focus is on the addition and configuration of the NetX DHCP Client module to a Renesas Synergy Platform project. For details on the operation of this module, consult the document, *NetX™ Dynamic Host Configuration Protocol for Clients User's Guide* for the Renesas Synergy™ Platform. It is part of *X-Ware™ Component Documents for Renesas Synergy*™ zip file available from the Synergy Gallery (https://www.renesas.com/synergy/software).

Contents

1. NetX DHCP Client Module Features

- The NetX DHCP Client module is compliant with RFC2132, RFC2131, and related RFCs.
- The module provides high-level APIs to:
  - Create and delete a DHCP client instance
  - Start, stop, and reinitialize the DHCP client (to restart the DHCP client protocol)
  - Request a specific IP Address from the server
  - Specify the network interface to run the DHCP client on
  - Supply an application-created packet pool to the DHCP client

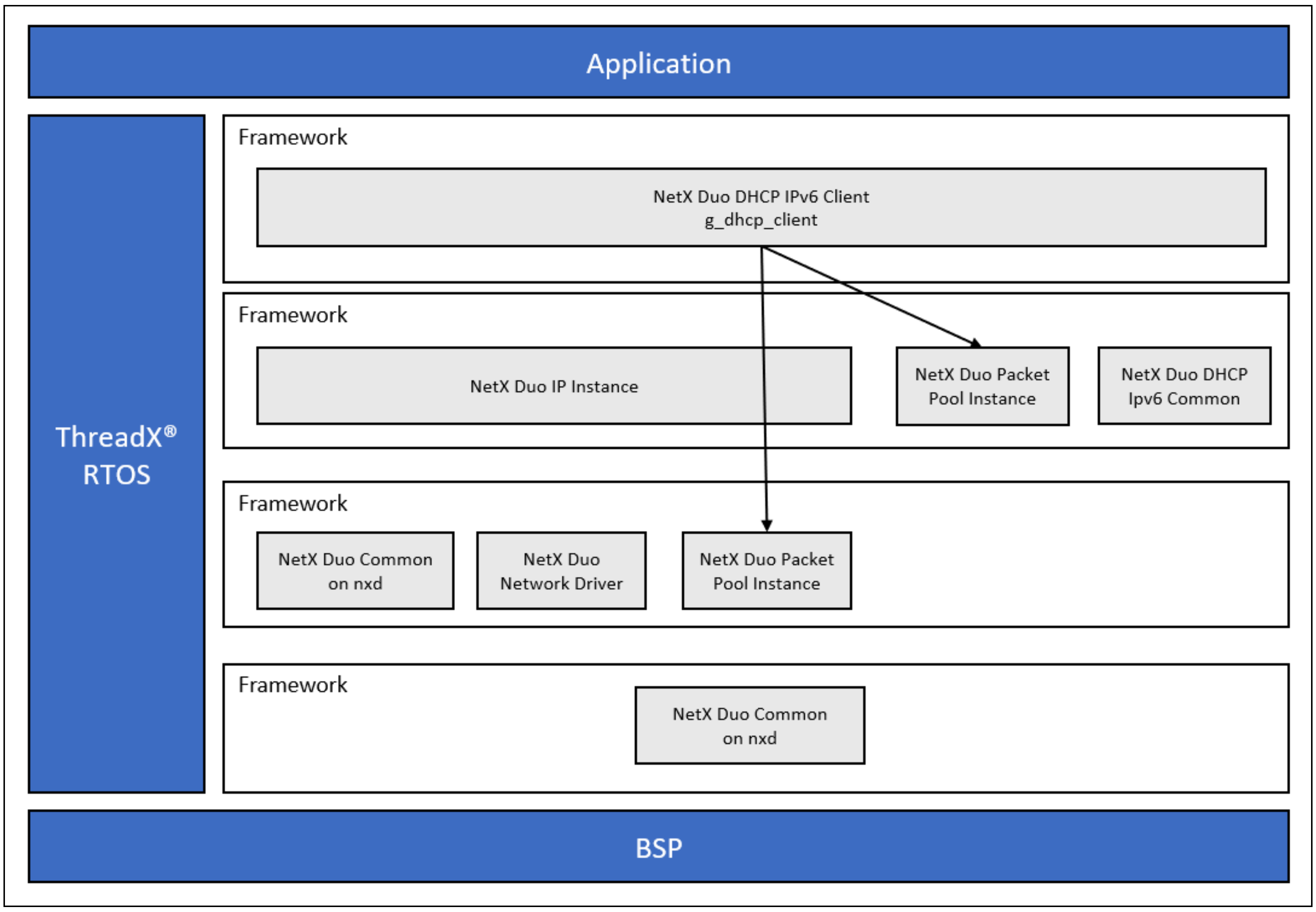


Figure 1. NetX DHCP Client Module Block Diagram

2. NetX DHCP Client Module APIs Overview

The NetX DHCP Client module defines APIs for creating and starting the DHCP client. Internally, the DHCP client handles all communication with the DHCP server to obtain an IP address. The following table lists the complete set of module APIs with an example API call and a brief description of each. A status return values table follows the API summary table.

Table 1. NetX DHCP Client Module API Summary

Function Name	Example API Call and Description
nx_dhcp_create	`nx_dhcp_create(&my_dhcp, &my_ip, "My DHCP");` Create a DHCP instance.
nx_dhcp_clear_broadcast_flag	`nx_dhcp_clear_broadcast_flag(&my_dhcp, NX_TRUE);` Clear broadcast flag on Client messages.

Function Name	**Example API Call and Description**
nx_dhcp_delete	`nx_dhcp_delete(&my_dhcp);` Delete a DHCP instance.
nx_dhcp_decline	`nx_dhcp_decline(&my_dhcp);` Send Decline message to server.
nx_dhcp_force_renew	`nx_dhcp_force_renew(&my_dhcp);` Handle Server force renew message.

nx_dhcp_packet_pool_set	`nx_packet_pool_create(&dhcp_pool, "DHCP Client Packet Pool",`
	`NX_DHCP_PACKET_PAYLOAD, pointer, (15 * NX_DHCP_PACKET_PAYLOAD));`
	
	`nx_dhcp_create(&dhcp_0, &ip_0, "janetsdhcp1");`
	
	`nx_dhcp_packet_pool_set(&my_dhcp, packet_pool_ptr);`
	Set the DHCP Client packet pool. By default, the DHCP Client creates its own packet pool.

nx_dhcp_release	`nx_dhcp_release(&my_dhcp);` Send Release message to server.
nx_dhcp_reinitialize	`nx_dhcp_reinitialize(&my_dhcp);` Clear DHCP client network parameters and clear IP address and gateway registered with the IP instance.
nx_dhcp_request_client_ip	`nx_dhcp_request_client_ip(&my_dhcp, IP(192,168,0,6), NX_TRUE);` Request a specific IP address.
nx_dhcp_send_request	`nx_dhcp_send_request(&my_dhcp, NX_DHCP_TYPE_INFORMREQUEST);` Send DHCP message to server (only INFORM_REQUEST is allowed).
nx_dhcp_server_address_get	`nx_dhcp_server_address_get(&dhcp_0, &server_address);` Retrieve DHCP Client's DHCP server address.
nx_dhcp_set_interface_index	`nx_dhcp_set_interface_index(&my_dhcp, 1);` Specify the network interface to run DHCP Client.
nx_dhcp_start	`nx_dhcp_start(&my_dhcp);` Start DHCP processing.
nx_dhcp_state_change_notify	`nx_dhcp_state_change_notify(&my_dhcp, my_state_change);` Notify application of DHCP state change.
nx_dhcp_stop	`nx_dhcp_stop(&my_dhcp);` Stop DHCP processing.

nx_dhcp_user_option_retrieve	`nx_dhcp_user_option_retrieve(&my_dhcp, NX_DHCP_OPTION_DNS_SVR,`
	`dns_ip_string, &size);`
	Retrieve the specified DHCP option.

nx_dhcp_user_option_convert	`nx_dhcp_user_option_convert(dns_ip_string);` Convert four bytes to ULONG.
The following services require that *Persistent client state* be enabled	
nx_dhcp_suspend	`nx_dhcp_suspend(&g_dhcp_client0);` Suspend the DHCP Client thread.

Function Name	Example API Call and Description
nx_dhcp_resume	`nx_dhcp_resume (&g_dhcp_client0);` Resume the DHCP Client thread.
nx_dhcp_client_update_time_remaining	`nx_dhcp_client_update_time_remaining(*g_dhcp_client0, 1000)` This updates the time remaining on the IP lease by the input time in timer ticks, such as the time interval while the DHCP Client thread was suspended.
nx_dhcp_client_create_record	`nx_dhcp_client_create_record(&g_dhcp_client0)` This fills in a client record structure associated with the DHCP Client based on Client lease data.
nx_dhcp_client_restore_record	`nx_dhcp_client_restore_record(&g_dhcp_client, client_record_ptr, time_elapsed)` The Client record points to data to restore to the DHCP Client itself, and time elapsed is subtracted from the DHCP Client time remaining on its lease.

Note: For details on operation and definitions for the function data structures, typedefs, defines, API data, API structures and function variables review the associated Express Logic User's Manual accessible as described in the Reference section later in this document.

Table 2. Status Return Values

Name	Description
NX_SUCCESS	Successful API call.
NX_PTR_ERROR*	Invalid pointer input.
NX_THREADS_ONLY_CALLER_CHECKING*	Invalid caller of this service.
NX_INVALID_INTERFACE	NetX is not enabled on the input interface
NX_NOT_ENABLED	Not enabled to set the DHCP Client packet pool.
NX_DHCP_NOT_STARTED	DHCP Client not started.
NX_DHCP_NOT_BOUND	The IP address has not been leased so the current operation is not allowed.
NX_DHCP_INVALID_MESSAGE	Illegal message type to send.
NX_DHCP_BAD_INTERFACE_INDEX*	An invalid network interface supplied
NX_DHCP_UNKNOWN_OPTION	Unknown DHCP option to extract from DHCP server response
NX_DHCP_INVALID_IP_REQUEST*	Invalid address for the DHCP Client to request
NX_DHCP_INVALID_PAYLOAD	Packet pool for the DHCP Client has insufficient payload
NX_DHCP_ALREADY_STARTED	DHCP Client thread task has already started
NX_DHCP_PARSE_ERROR	Unable to parse requested option from Server response
NX_DHCP_DEST_TO_SMALL	Supplied buffer too small to hold the requested option data for user requesting option data

Note: Lower-level drivers may return common error codes. Refer to the ***SSP User's Manual*** API References for the associated module for a definition of all relevant status return values.
*These error codes are returned only if error checking is enabled. For details on error checking services in NetX, refer to the NetX User Guide for the Renesas Synergy™ Platform.

3. NetX DHCP Client Module Operational Overview

The DHCP Client module handles all the details in obtaining an IP address, registering it with the IP instance, and renewing the IP address lease before the lease expires.

A NetX IP instance is created; it has a zero IP address and is enabled for User Datagram Protocol (UDP) and the Address Resolution Protocol (ARP), respectively. The Reverse ARP (RARP) should not be enabled; a DHCP Client is then created. Its creation creates an UDP socket for sending and receiving DHCP messages. By default, the DHCP Client creates its own packet pool based on the settings **Minimum packet payload size** and **Number of packets in packet pool** (see the following table). The **Minimum Client**

packet payload size must be large enough to include DHCP data, IP, UDP headers, and the physical frame header.

- For Ethernet networks, this minimum payload is 592 bytes, which is the default setting of **Minimum Client packet payload size**.
- For other network types (such as Wi-Fi), the frame-header size is larger, and minimum size must be increased correspondingly.

When the packet pool is created, the DHCP Client verifies that the packet payload is not less than the minimum required payload size.

The DHCP Client can request a specific IP address using the `nx_dhcp_request_client_ip` service and supply a non-zero IP address before starting the DHCP Client. Normally, the request is useful for a device previously assigned an IP address that wishes to keep the same IP address. Note the server is not obligated to accommodate this request.

When the DHCP Client is started, it binds the socket to a DHCP port (by default 68) and begins sending and receiving packets through that socket. When the client is assigned an IP address, it automatically registers the IP address with NetX. The server supplies the network mask and network gateway, and the DHCP Client module updates NetX with that information.

When the server assigns the Client an IP address, it may also supply other network information, such as the DNS server and the NTP server. The application can obtain those values using the `nx_dhcp_user_option_retrieve` service.

The DHCP Client keeps track of the time remaining on the IP lease. It automatically sends Renew requests to the DHCP Server when time to renew. If the server is no longer on the network, or is otherwise not responding, the client sends broadcast requests to any DHCP Server on the network. If the lease expires without a renewal or rebinding, the client is returned to the `NX_DHCP_STATE_INIT` state. The device may continue to use the IP address. If a DHCP Server is later available, and the device is able to request an IP address, it must no longer use the old IP address.

In busy networks, a DHCP Client socket queue can fill up with non-specific DHCP broadcast packets intended for other DHCP Client hosts. If the DHCP Client socket receive-queue fills up, any packets intended for the device may get dropped. To avoid this problem, the DHCP Client continually clears non-specific broadcast packets from the socket.

3.1 NetX DHCP Client Module Important Operational Notes and Limitations

3.1.1 NetX DHCP Client Module Operational Notes

Instead of the DHCP Client module creating the packet pool, the developer may prefer to supply a previously created packet pool. To do so, enable the *Use application packet pool* option, then use the nx_dhcp_packet_pool_set service to set the DHCP Client's packet pool.

The DHCP Client verifies that the packet payload is not less than the minimum required packet size.

The IP address offered to the client should be tested for 'uniqueness' on the local network, since the DHCP protocol does not require the server to check. To configure the DHCP Client to check, enable the *Send ARP probe* option.

The DHCP Client sends a series of ARP "probes" with its assigned IP address out on the network. If any host responds to these ARP requests/probes, the DHCP Client automatically sends a DECLINE message to the server and restarts the DHCP protocol to request another IP address. Otherwise, the DHCP Client proceeds to the bound state. The states of the client in the DHCP protocol are:

```
NX_DHCP_STATE_NOT_STARTED
NX_DHCP_STATE_INIT
NX_DHCP_STATE_SELECTING
NX_DHCP_STATE_REQUESTING
NX_DHCP_STATE_BOUND
NX_DHCP_STATE_RENEWING
NX_DHCP_STATE_REBINDING
```

Note: If ARP probe is enabled, the NetX DHCP Client enters a temporary state called `NX_DHCP_STATE_ADDRESS_PROBING` before the `NX_DHCP_STATE_BOUND` state.

The application can detect if the DHCP Client has completed (has an IP address) in a couple of ways. First, it can call the `nx_ip_status_check` service with the `NX_IP_ADDRESS_RESOLVED` option. Alternatively, it can use the `nx_dhcp_state_change_notify` service which notifies the application when the DHCP Client state changes. When the DHCP Client reaches the bound state, (state == `NX_DHCP_STATE_BOUND`) it has a valid IP address.

If there is a need to stop the DHCP Client thread task, call the `nx_dhcp_stop` service. To restart the Client, first call the `nx_dhcp_reinitialize` service to clear the DHCP Client data and also clear network parameters registered with NetX. Then, the DHCP Client is restarted with the `nx_dhcp_start` call.

3.1.2 NetX DHCP Client Module Limitations

- The DHCP Client does not support the INFORM_REQUEST message. The application can send this message out using the `nx_dhcp_send_request` service, but the data from the Server is not extracted and saved to the DHCP Client.
- The options supported `nx_dhcp_user_option_retrieve` are limited to the following:

```
NX_DHCP_OPTION_SUBNET_MASK
NX_DHCP_OPTION_TIME_OFFSET
NX_DHCP_OPTION_GATEWAYS
NX_DHCP_OPTION_TIMESVR
NX_DHCP_OPTION_DNS_SVR
NX_DHCP_OPTION_NTP_SVR
NX_DHCP_OPTION_DHCP_LEASE
NX_DHCP_OPTION_DHCP_SERVER
NX_DHCP_OPTION_RENEWAL
NX_DHCP_OPTION_REBIND
```

- Refer to the following documents (also listed in the References Section) for additional limitations for this module: *NetX Dynamic Host Configuration Protocol for Clients User's Guide* for the Renesas Synergy™ Platform Latest SSP Release Notes.

4. Including the NetX DHCP Client Module in an Application

This section describes how to include the NetX DHCP Client module in an application using the Synergy Software Platform (SSP) Configurator in your Integrated Solution Development Environment (ISDE).

Note: It is assumed you are familiar the steps to creating a project, adding threads, adding a stack to a thread, and configuring a block within the stack. If you are unfamiliar with any of these items, refer to the SSP User's Manual to learn how to manage each of these important steps in creating SSP-based applications.

To add the NetX DHCP Client module to an application, simply add it to a thread using the stacks selection sequence listed in the following table. (The default name for the NetX DHCP Client is `g_dhcp_client0`. This name can be changed in the associated Properties window.)

Table 3. NetX DHCP Client Module Selection Sequence

Resource	**ISDE Tab**	**Stacks Selection Sequence**
`g_dhcp_client0` NetX DHCP Client	Threads	New Stack> X-Ware> NetX> Protocols> NetX DHCP Client

When the NetX DHCP Client module on `g_dhcp_client0` is added to the thread stack as shown in the following figure, the configurator automatically adds the needed lower-level NetX components and drivers. A driver or NetX component needing additional configuration is box-text highlighted in Red. Modules with a Gray band are individual **standalone** modules. Modules with a Blue band are shared or common; they only need to be added once to be used by multiple stacks. Modules with a Pink band can require additional lower level drivers. Sometimes these drivers are optional or recommended, and this information is indicated with the inclusion of this text in the block. If additional lower-level drivers are required, the module description includes **Add** in the text. Clicking a Pink-banded module brings up the **New** icon and displays possible choices for selection.

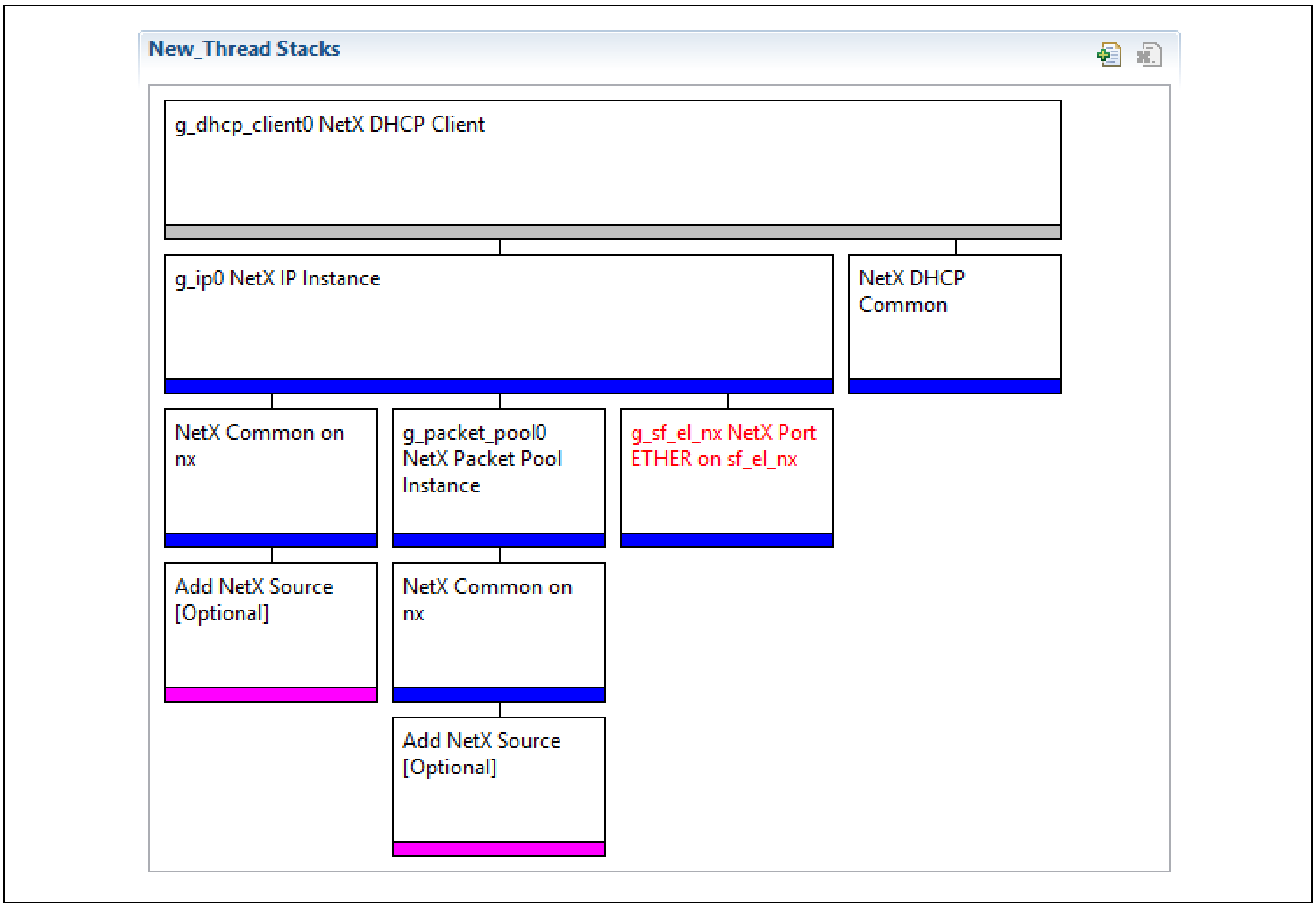

New_Thread Stacks
g_dhcp_client0 NetX DHCP Client
g_ip0 NetX IP Instance
NetX DHCP Common
NetX Common on nx
g_packet_pool0 NetX Packet Pool Instance
g_sf_el_nx NetX Port ETHER on sf_el_nx
Add NetX Source [Optional]
NetX Common on nx
Add NetX Source [Optional]

Figure 2. NetX DHCP Client Module Stack

5. Configuring the NetX DHCP Client Module

The NetX DHCP Client module must be configured by the user for the desired operation. The SSP configuration window automatically identifies (by highlighting the block in red) any required configuration selections, such as interrupts or operating modes, configured for lower-level modules to enable successful operation. Only properties that can be changed without causing conflict are available for modification. Properties that are **locked** with a lock icon in the **Properties** window in the ISDE are not available for changes. This approach simplifies the configuration process and makes it much less error-prone than previous ‘manual’ approaches to configuration. The available configuration settings and defaults for all the user-accessible properties are given in the properties tab within the SSP Configurator and are shown in the following tables for easy reference.

One of the properties most often identified as requiring a change is the interrupt priority; this configuration setting is available within the **Properties** window of the associated module. Simply select the indicated module to view it in the properties window; the interrupt settings are often towards the bottom of the properties list, so scroll down until they become available. Also note that the interrupt priorities listed in the **Properties** window in the ISDE indicate the validity of the setting based on the MCU targeted (CM4 or CM0+). This level of detail is not included in the following configuration properties tables but is easily visible when configuring interrupt-priority levels in the ISDE.

Note: You may want to open your ISDE, create the NetX DHCP Client Framework, and explore the property settings while reviewing the configuration settings in the following table. This helps to orient you and can be a useful **hands-on** approach to learning the ins and outs of developing with the SSP.

Table 4. Configuration Settings for the NetX DHCP Client Module

Parameter	Value	Description
Internal thread priority	3	Internal thread priority selection
Internal thread stack size (bytes)	4096	Internal thread stack size (bytes) selection
Timeout between DHCP messages processed (seconds)	1	Timeout between DHCP messages processed (seconds) selection
Packet allocate timeout (seconds)	1	Packet allocate timeout (seconds) selection
Use BOOTP	Enable, Disable Default: Disable	Use BOOTP selection
Send ARP probe	Enable, Disable Default: Disable	Send ARP probe selection
Packet ARP probe timeout (seconds)	10	Packet ARP probe timeout (seconds) selection
Maximum retransmission timeout (seconds)	64	Maximum retransmission timeout (seconds) selection
Minimum renew timeout (seconds)	60	Minimum renew timeout (seconds) selection
Minimum retransmission timeout (seconds)	4	Minimum retransmission timeout (seconds) selection
Client packet payload size (bytes)	592	Client packet payload size (bytes) selection
Number of packets in internal packet pool	5	Number of packets in internal packet pool selection
Server message check interval (unit = processing interval). Disabled = 0xFFFFFFF	0xFFFFFFF	Server message check interval (unit = processing interval). Disabled = 0xFFFFFFF selection
Persistent client state	Enable, Disable Default: Disable	Persistent client state selection
Use application packet pool	Enable, Disable Default: Disable	Use application packet pool selection
Maximum message size support	Enable, Disable Default: Disable	Maximum message size support selection
DHCP options buffer size (bytes)	312	DHCP options buffer size (bytes) selection
Name	g_dhcp_client0	Module name

Note: The above configuration setting examples and defaults are for a project using the S7G2 Synergy MCU group. Other MCUs may have different default values and available configuration settings.

5.1 Configuration Settings for the NetX DHCP Client Lower-Level Modules

In some cases, settings other than the defaults for lower-level modules can be desirable. For example, it might be useful to select different Ethernet interface pins and resets. The configurable properties for the lower-level stack modules are provided in the following tables for completeness and as a reference.

Most property settings for lower-level modules can be determined by inspection of the associated **Properties** window from the SSP configurator. Typically, only a small number of settings must be modified from the default for lower-level modules, as indicated via the red text in the thread stack block.

Notice that some of the configuration properties must be set to a certain value for proper framework operation and are locked to prevent user modification. The following tables identify all the settings available within the properties section for this module.

Table 5. Configuration Settings for the NetX IP Instance

ISDE Property	Value	Description
Name	g_ip0	Module name
IPv4 Address (use commas for separation)	0,0,0,0	IPv4 Address selection
Subnet Mask (use commas for separation)	255,255,255,0	Subnet Mask selection
IP Helper Thread Stack Size (bytes)	2048	IP Helper Thread Stack Size (bytes) selection
IP Helper Thread Priority	3	IP Helper Thread Priority selection
ARP	Enable	ARP selection
ARP Cache Size in Bytes	520	ARP Cache Size in Bytes selection
Reverse ARP	Enable, Disable Default: Disable	Reverse ARP selection
TCP	Enable, Disable Default: Enable	TCP selection
UDP	Enable	UDP selection
ICMP	Enable, Disable Default: Enable	ICMP selection
IGMP	Enable, Disable Default: Enable	IGMP selection
IP fragmentation	Enable, Disable Default: Disable	IP fragmentation selection

Note: The above configuration setting examples and defaults are for a project using the S7G2 Synergy MCU group. Other MCUs may have different default values and available configuration settings.

Table 6. Configuration Settings for the NetX DHCP Common Instance

ISDE Property	Value	Description
Type of Service for UDP requests	Normal, Minimum delay, Maximum data, Maximum reliability, Minimum cost Default: Normal	Type of service UDP requests selection
Fragmentation option	Don't fragment, Fragment okay Default: Don't fragment	Fragment option selection
Time to live	128	Time to live selection
Packet Queue depth	5	Packet queue depth selection

Note: The above configuration setting examples and defaults are for a project using the S7G2 Synergy MCU group. Other MCUs may have different default values and available configuration settings.

Table 7. Configuration Settings for the NetX Packet Pool Instance

ISDE Property	Value	Description
Name	g_packet_pool0	Module name
Packet Size in Bytes	640	Packet size selection
Number of Packets in Pool	16	Number of packets in pool selection

Note: The above configuration setting examples and defaults are for a project using the S7G2 Synergy MCU group. Other MCUs may have different default values and available configuration settings.

Table 8. Configuration Settings for the NetX Port ETHER

ISDE Property	Value	Description
Parameter Checking	BSP, Enabled, Disabled Default: BSP	Enable or disable the parameter checking
Channel 0 Phy Reset Pin	IOPORT_PORT_09_PIN_03	Channel 0 Phy reset pin selection
Channel 0 MAC Address High Bits	0x00002E09	Channel 0 MAC address high bits selection
Channel 0 MAC Address Low Bits	0x0A0076C7	Channel 0 MAC address low bits selection
Channel 1 Phy Reset Pin	IOPORT_PORT_07_PIN_06	Channel 1 Phy reset pin selection
Channel 1 MAC Address High Bits	0x00002E09	Channel 1 MAC address high bits selection
Channel 1 MAC Address Low Bits	0x0A0076C8	Channel 1 MAC address low bits selection
Number of Receive Buffer Descriptors	8	Number of receive buffer descriptors selection
Number of Transmit Buffer Descriptors	32	Number of transmit buffer descriptors selection
Ethernet Interrupt Priority	Priority 0 (highest), Priority 1:2, Priority 3 (CM4: valid, CM0+: lowest- not valid if using ThreadX), Priority 4:14 (CM4: valid, CM0+: invalid), Priority 15 (CM4 lowest - not valid if using ThreadX, CM0+: invalid) Default: Disabled	Ethernet interrupt priority selection
Name	g_sf_el_nx	Module name
Channel	0	Channel selection
Callback	NULL	Callback selection

Note: The above configuration setting examples and defaults are for a project using the S7G2 Synergy MCU group. Other MCUs may have different default values and available configuration settings.

Table 9. Configuration Settings for the NetX Packet Pool Instance (when added as new)

ISDE Property	Value	Description
Name	g_packet_pool1	Module name
Packet Size in Bytes	640	Packet size selection
Number of Packets in Pool	16	Number of packets in pool selection

Note: The above configuration setting examples and defaults are for a project using the S7G2 Synergy MCU group. Other MCUs may have different default values and available configuration settings.

Table 10. Configuration Settings for the NetX Common Instance

ISDE Property	Value	Description
No configurable settings		

Note: The above configuration setting examples and defaults are for a project using the S7G2 Synergy MCU group. Other MCUs may have different default values and available configuration settings.

5.2 NetX DHCP Client Module Clock Configuration

The ETHERC peripheral module uses PCLKA as its clock source. The PCLKA frequency is set by using the SSP configurator clock tab prior to a build, or by using the CGC Interface at run-time.

5.3 NetX DHCP Client Module Pin Configuration

The ETHERC peripheral module uses pins on the MCU to communicate to external devices. I/O pins must be selected and configured as required by the external device. The following pin selection table identifies a method to select the pins within the SSP configuration window, with the pin configuration table identifying an example selection for the I2C.

Note: The operation mode selection determines what peripheral signals are available and thus what MCU pins are required.

Table 11. Pin Selection for the ETHERC Module

Resource	ISDE Tab	Pin selection Sequence
ETHERC	Pins	Select Peripherals > Connectivity:ETHERC > ETHERC1.RMII

Note: The selection sequence assumes ETHERC1 is the desired hardware target for the driver.

Table 12. Pin Configuration Settings for the ETHERC1

Property	Value	Description
Operation Mode	Disabled, Custom, RMII (Default: Disabled)	Select RMII as the Operation Mode for ETHERC1
Pin Group Selection	Mixed, _A only (Default: _A only)	Pin group selection
REF50CK	P701	REF50CK Pin
TXD0	P700	TXD0 Pin
TXD1	P406	TXD1 Pin
TXD_EN	P405	TXD_EN Pin
RXD0	P702	RXD0 Pin
RXD1	P703	RXD1 Pin
RX_ER	P704	RX_ER Pin
CRS_DV	P705	CRS_DV Pin
MDC	P403	MDC Pin
MDIO	P404	MDIO Pin

Note: The table lists configuration setting examples and defaults for a project using the S7G2 Synergy MCU group and the SK-S7G2 Kit. Other Synergy Kits and MCUs may have different available pin configuration settings.

6. Using the NetX DHCP Client Module in an Application

The following example assumes a system that is already established with a working and enabled IP, ARP, and UDP, and the link running. The typical steps in using the NetX DHCP Client module in an application are:

1. Set the DHCP features for the DHCP Client (request specific IP address, clear the broadcast flag, set the interface on which DHCP Client runs) before starting the DHCP Client. [Optional]
2. Start the DHCP with the `nx_dhcp_start` API
3. Wait for IP Address resolution by calling nx_ip_status_check (a NetX library service call) or check for the bound state in the DHCP Client state-change callback function.
4. A valid IP Address is now on lease and the application can start using NetX services for sending and receiving packets.
5. The DHCP Client will automatically request IP lease renewal based on the time remaining on the IP lease (as long as the DHCP Client thread task is still running). [Optional]

6. To stop the DHCP Client thread task, call `nx_dhcp_stop`. To restart the DHCP Client call `nx_dhcp_reinitialize` and then call *nx_dhcp_start*. [Optional]
7. Add or modify the existing DHCP Client settings. [Optional]

The following figure shows these common steps in a typical operational flow diagram.

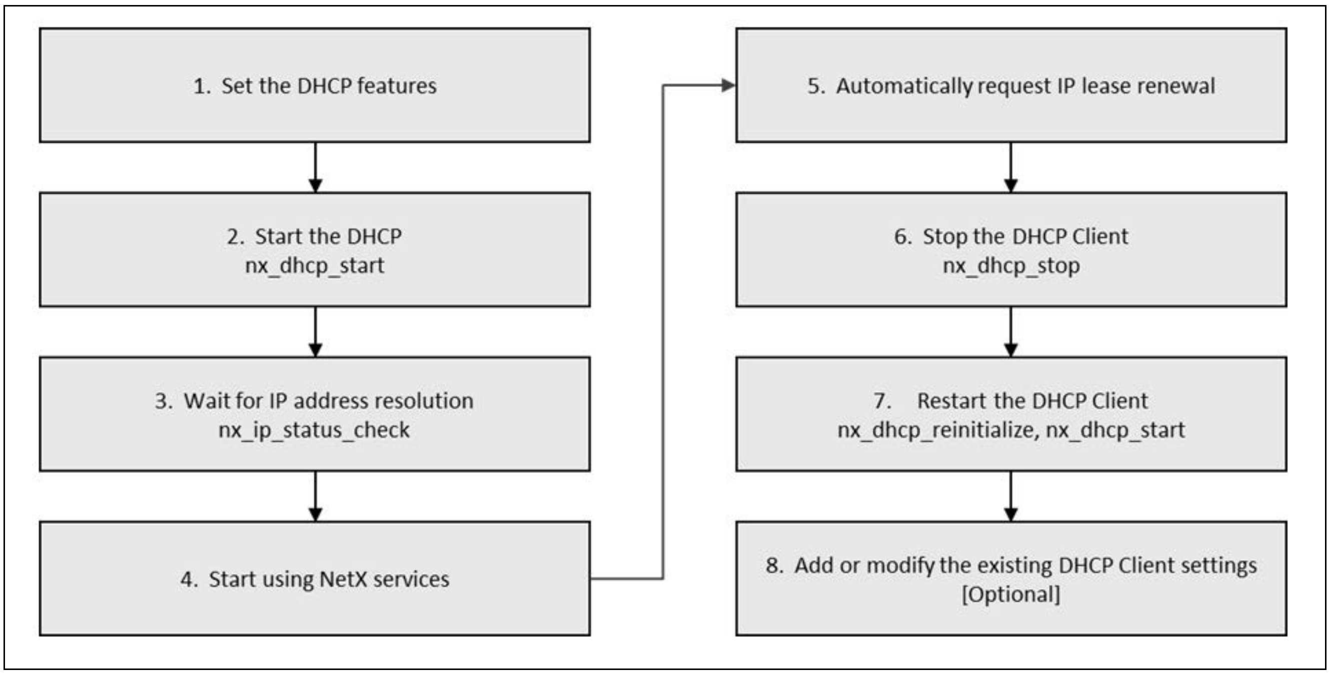

1. Set the DHCP features
2. Start the DHCP nx_dhcp_start
3. Wait for IP address resolution nx_ip_status_check
4. Start using NetX services
5. Automatically request IP lease renewal
6. Stop the DHCP Client nx_dhcp_stop
7. Restart the DHCP Client nx_dhcp_reinitialize, nx_dhcp_start
8. Add or modify the existing DHCP Client settings [Optional]

Figure 3. Flow Diagram of a Typical NetX DHCP Client Module Application

7. The NetX DHCP Client Module Application Project

The application project associated with this module guide demonstrates common steps in using the NetX DHCP Client module in a full design. The project can be found using the link provided in the References Section at the end of this document. You may want to import and open the application project within the ISDE and view the NetX DHCP Client configuration settings for the module. You can also read over the code in (`DHCPv4_Client_Netx_MG.c`) which is used to illustrate the NetX DHCP Client module APIs in a complete design.

This application project demonstrates the typical use of the NetX DHCP Client module APIs. The application project configures the DHCP Client with some common optional features before starting the DHCP Client thread task. The application project waits to be assigned a valid IP address, and once this happens, it tests the IP address by pinging on the DHCP and DNS servers.

The `DHCPv4_Client_Netx_MG.c` file is located in the project once it has been imported into the ISDE. Note that this is not the auto-generated code file `dhcp_thread_entry.c`. The dhcp_thread_entry calls a function defined in `DHCPv4_Client_Netx_MG.c` file to run a DHCP Client session.

The following table identifies target versions for the associated software and hardware used by the Application Project.

Table 13. Software and Hardware Resources Used by the Application Project

Resource	**Revision**	**Description**
e^2 studio	7.3.0 or later	Integrated Solution Development Environment
SSP	1.6.0 or later	Synergy Software Platform
IAR EW for Renesas Synergy	8.23.3 or later	IAR Embedded Workbench® for Renesas Synergy™
SSC	7.3.0 or later	Synergy Standalone Configurator
SK-S7G2	v3.0 to v3.3	Starter Kit

The application project requires connecting a USB micro cable on the J19 connector to a PC to display the output to the Renesas debug virtual console and DHCP Client device that is connected to a network with a DHCP Server through the RJ45 connector (J11). Optionally, the application project can use a packet capture program, such as Wireshark, that is running on a local PC. The following figure shows the application project as a simple flow diagram.

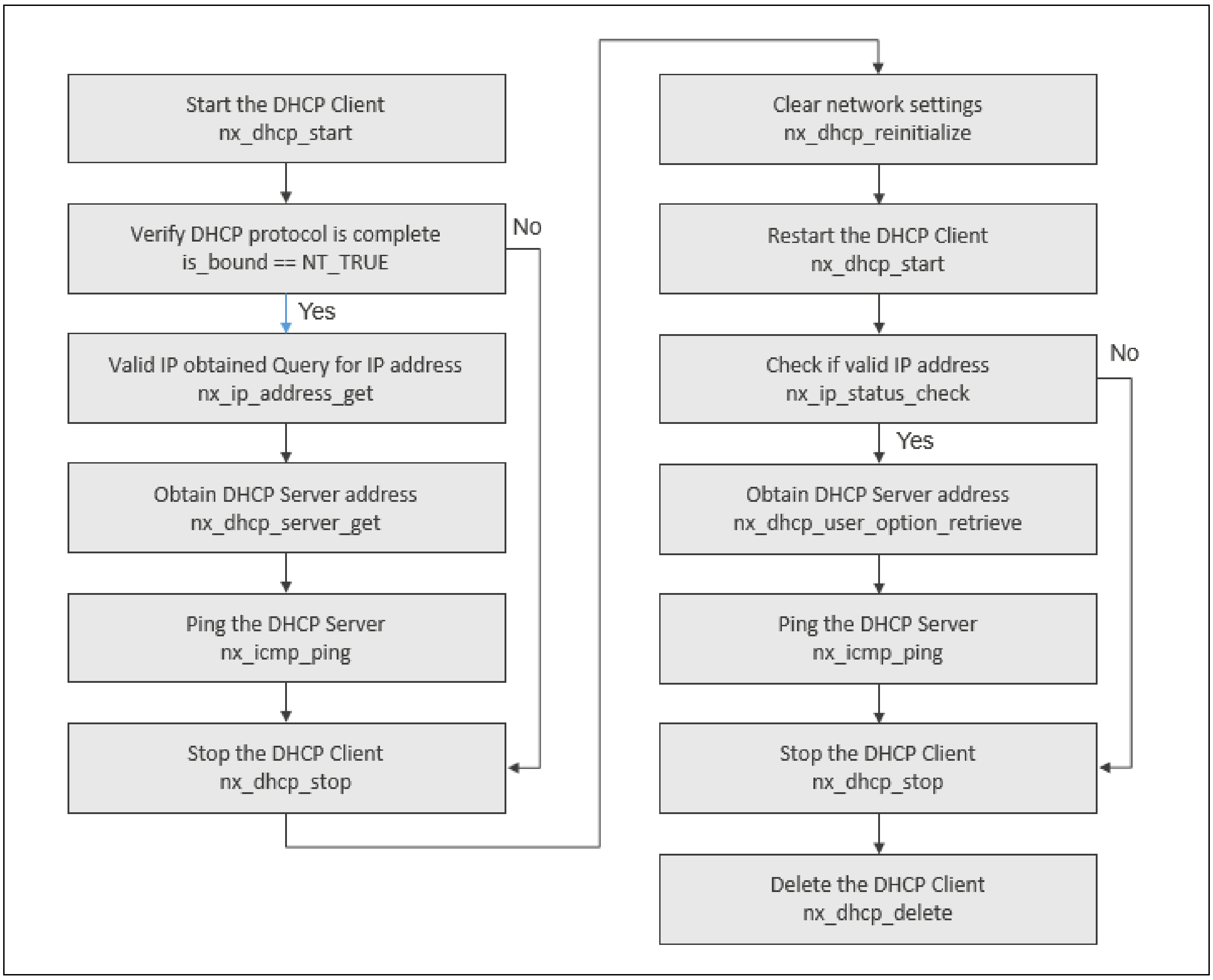


Figure 4. NetX DHCP Client Module Application Project Flow Diagram

The `DHCPv4_Client_Netx_MG.c` file is located in the project once it has been imported into the ISDE. You can open this file within the ISDE and use the description provided to learn key uses of the APIs.

The progress of the DHCP protocol can also be viewed using a packet trace capture (such as Wireshark) running on any PC located on the same network. No special configuration is required since the DHCP packets in this application are broadcast and visible to all the hosts on the network.

At the top of the `dhcp_thread_entry()`, the application waits a few seconds to allow the IP thread task and the network driver to initialize. Both need to know a few things about each other before the NetX library calls work correctly. Note that the `nx_ip_status_check` service is not used with `NX_IP_ADDRESS_RESOLVED`, and this is because currently the application has a zero IP address. Next, the thread entry function calls the `run_dhcp_client_session` function to actually run the session.

DHCP Client Properties

The application project uses all the default settings for the NetX DHCP Client properties and has limited debug output (semi hosting).

Using the DHCP State Change Callback

Before starting the DHCP Client, `run_dhcp_client_session` registers a DHCP state-change callback function using the `nx_dhcp_state_change_notify` service. This enables application thread to be notified of the DHCP state changes. The advantage of this callback is the application thread need not wait or poll the IP instance for a valid IP address (such as when the `NX_DHCP_STATE_BOUND` is achieved), and can perform other tasks instead. The callback function in this application only checks for the bound state.

Starting the DHCP Client Thread Task

The DHCP Client is started using the nx_dhcp_start service. This service binds the client socket to the DHCP port, and activates the client thread and timer. The application thread then periodically 1) checks if the client is bound yet, and 2) relinquishes control to other threads to run before checking again.

Note that there is an upper limit to how long it waits to reach the bound state. This maximum wait is set by the `WAIT_TO_BE_BOUND` macro defined in `DHCPv4_Client_Netx_MG.h` as (`2*NX_IP_PERIODIC_RATE`). `NX_IP_PERIODIC_RATE` is used in NetX to convert timer ticks to seconds and automatically set internally in the Synergy environment.

DHCP Services Available in the Bound State

If the application is notified and the DHCP Client is bound before this wait time-out expires, the `run_dhcp_client_session` queries the DHCP Client for the server IP address using the `nx_dhcp_server_address_get` service. It gets its own IP address from the NetX service `nx_ip_address` set. At this point, the application can start sending and receiving non-broadcast packets. To demonstrate a valid IP address, `run_dhcp_client_session` pings the DHCP Server.

Once bound to an IP address, the DHCP Client thread task keeps track of the time remaining on the IP lease while it is running. When the lease is near to expiration, the DHCP Client thread automatically initiates renewing the IP lease at the appropriate time. In this application, the DHCP Client is intentionally stopped so this does not happen.

Stopping and Restarting the DHCP Client the First Time

There may be instances where the application wants to stop the DHCP Client. For example, if the client needs to be powered down, detects it is on another network, or the lease time assigned is longer than the host needs (so there is no need to keep a thread running.) Before it can be restarted, the client must be stopped and reinitialized.

The application calls the `nx_dhcp_stop` service to suspend the DHCP Client thread task, unbinds the DHCP Client socket, and deactivates the DHCP Client timer. Also, it puts the DHCP Client in a state to be restarted. At this point, there is no DHCP Client thread activity. The activity does not clear network parameters, so the application can still send and receive packets with the assigned IP address as the source.

To clear network parameters from NetX, (parameters such as the IP address, network mask, and the gateway), then `run_dhcp_client_session`, which calls the `nx_dhcp_reinitialize` service. This process also clears the network parameters registered with the DHCP Client record.

The `run_dhcp_client_session` resets the is_bound flag and restarts the DHCP Client by calling the nx_dhcp_start service as before. This time it calls `nx_ip_status_check` to check whether it has received another IP address lease. Again, there is maximum wait limit set to wait for another IP address to be assigned. Note: there is no guarantee the server would assign the same IP address to the device.

On reaching the bound state a second time, `run_dhcp_client_session` queries the DHCP Client for the DNS Server using the `nx_dhcp_user_option_retrieve` service. This service can also be used to query the DHCP Client for IP lease time and other network information (see Section 3.1.2 for a list of options supported.)

To verify a valid IP address, the `run_dhcp_client_session` pings the DNS Server.

Stopping and Deleting the DHCP Client

Before stopping the DHCP Client the second time, the `run_dhcp_client_session` releases the IP address using the `nx_dhcp_release` service. This service is not required but is considered **good network behavior** to let the DHCP Server know the address is now available for other hosts. The DHCP Client can only release an IP address if it is bound to that IP address.

All DHCP Client activity is stopped with the nx_dhcp_stop call. The DHCP Client itself is then deleted, (including the DHCP timer, threads, and UDP socket) by calling the `nx_dhcp_delete` service.

To verify if any errors occurred, the `run_dhcp_client_session` checks the error_counter variable for a non-zero value. This value increments each time an error occurs. If it is zero, `NX_SUCCESS` returns; otherwise, a non-zero error status is returned. The debug output using semi-hosting also records a trace of the DHCP session in the Renesas Debug Virtual Console.

`DHCPv4_Client_Netx_MG.c` also defines the DHCP state change callback function, `my_notify_callback`. This callback simply checks each notification for the state to be `NX_DHCP_STATE_BOUND` (bound state), and then sets a flag for `run_dhcp_client_`session to check whether an IP lease has been assigned. Note that this flag must be cleared between stopping and restarting the DHCP Client thread, since it is only a true/false value, not a counter.

Note: It is assumed you are familiar with using `printf()` the Debug Console in the SSP. If you are unfamiliar with this, refer to the **How do I Use Printf() with the Debug Console in the Synergy Software Package** Knowledge Base article, available in the References Section at the end of this document. You can see results via the watch variables in the debug mode.

8. Customizing the NetX DHCP Client Module for a Target Application

A brief description of DHCP Client configuration settings commonly changed in a DHCP Client applications follows. The details are given in the context of this application project:

Requesting a Specific IP address

The application may wish to request a specific IP address from the DHCP Server. If so, it should call the `nx_dhcp_request_client_ip` API before `nx_dhcp_start` is called in this application project. This is often useful for a device that wants to keep the same IP address. By setting the third input in this API, `skip_discover_message`, to `NX_TRUE`, the application is requesting that the DISCOVER and OFFER steps be omitted (a normal transaction is **DISCOVER -> OFFER -> REQUEST -> ACK)**. This reduces the DHCP protocol to one REQUEST message from the Client and one ACK message from the Server. It is up to the Server to accommodate either or both requests. In the event it does not, the DHCP Client automatically reverts to the normal four-step process.

Supplying a user-defined packet pool for the DHCP Client

The application may wish to supply the packet pool to the DHCP Client rather than the Client creating its own packet pool which it is defaulted to do. The advantages of using separate packet pools for different components of an application is that memory can be optimized for the expected usage. It also simplifies tracking down packet-pool leaks, and/or problems with packet-pool depletion.

To do so, enable the Use application packet pool property of the DHCP Client stack element, then create a separate packet pool from the one used by the IP instance (usually designated `g_packet_pool0`.) Click on the **+** icon in the **Thread Stack** elements and choose **X-Ware -> NetX -> Netx Packet Pool Instance**; this creates a packet pool for the DHCP Client. Note that the packet pool payload must be a minimum of 576 bytes plus the size of the Ethernet frame header.

Before calling the `nx_dhcp_start` API, register the new packet pool (which defaults to `g_packet_pool1`) with the DHCP Client by calling the `nx_dhcp_packet_pool_set` API. Note that it is up to the application to delete the packet pool when it no longer has use for it. The DHCP Client deletes the packet pool only if it created it in the first place.

Enabling ARP Probes

The RFC 2131 recommends that a device using DHCP to obtain an IP address verify that it is not in use by another host. This check is done by sending ARP probes out immediately after being assigned the IP address. If no hosts respond to these probes, the device can assume the address is not in use. NetX DHCP Client performs this service if the **Sending ARP Probes** property is **enabled** on the **DHCP Client stack** element. The DHCP Client is set with a callback that NetX uses to notify the DHCP Client of an ARP conflict. This allows the DHCP Client to verify the uniqueness of an IP address before promoting the DHCP Client to the bound state. If another host does respond, then the DHCP Client sends a DECLINE message to the Server and automatically restarts the DHCP protocol at the INIT state.

Note that if **Sending ARP Probes** is **enabled**, the application must expect to wait longer to achieve the bound state. The number of probes is specified by the ARP probe count property and defaults to 2. The interval to wait for a response (and before sending the next probe) is specified by the ARP probe wait time that defaults to 1 second. (There is also a random delay imposed on the wait time.) The minimum and maximum wait time is specified by Maximum ARP probe wait time (seconds) and Maximum ARP probe wait time (seconds) properties which default to 1 and 2 seconds, respectively. Using these defaults, the `WAIT_TO_BE_BOUND` defined in **DHCPv4_Client_Netx_MG.h** should be adjusted to (**4*NX_IP_PERIODIC_RATE**) to allow enough time for the ARP Probe process to complete and the DHCP Client to achieve the bound state.

Accessing DHCP Servers behind a Router

The NetX DHCP Client has a clear broadcast flag service intended to allow a device to access a server behind a router, such as outside the local network. This flag can only happen if the DHCP Server sends unicast packets through the router to the client. But since the device has no IP address, it would normally be unable to receive a unicast OFFER or ACK from the server. However, the NetX IP layer does accept packets with a zero destination IP address. Therefore, the packet is forwarded up to the UDP layer and onto the DHCP Client itself. The DHCP Client can signal the server to send unicast packets by calling `nx_dhcp_clear_broadcast_flag` service with the `clear_flag input` set to `NX_TRUE`.

More Uses of the State Change Callback

In the event the application fails to achieve the bound state, the callback function in this application can be expanded to check other states the DHCP Client has achieved. This may help resolve the reason why a DHCP session failed to progress to the bound state. For example, if the DHCP Client does not reach at least the `NX_DHCP_STATE_REQUESTING`, it has not received any server responses. If it reached the `NX_DHCP_STATE_ARP_PROBING`, and then is reset to the `NX_DHCP_STATE_INIT` again, that indicates the IP address assigned was not unique and the client has started the protocol over again.

Note that `NX_DHCP_STATE_INIT` is set each time the application calls `nx_dhcp_start`. If this state is reached again, it indicates a failure in one of the initialization states leading to the bound state, and the DHCP Client automatically resets the state to the `NX_DHCP_STATE_INIT` state.

Modification in the maximum number of DNS servers and gateways on the network.

`MAX_GATEWAYS` and `MAX_DNS_SERVERS` are set to 5, which means the API call to read number of DNS and gateways can successfully read maximum of 5 DNS servers and 5 gateways on the network, if there are more number of DNS or gateways on the network then the call `nx_dhcp_user_option_retrieve` will return the error `NX_DHCP_DEST_TO_SMALL` error, in that case increase the size of the buffers as there are more numbers of DNS or gateways on the networks.

9. Running the NetX DHCP Client Module Application Project

To run the **NetX DHCP Client Module Application Project** and to see it executed on a target kit, you can simply import it into your ISDE, compile, and run debug. Refer to the *Renesas Synergy™ Project Import Guide* (r11an0023eu0121-synergy-ssp-import-guide.pdf) included in this package) for instructions on importing the project into e^2 studio or IAR EW for Synergy and building/running the application.

To implement the NetX DHCP Client module application in a new project, follow the steps for defining, configuring, auto-generating files, adding code, compiling, and debugging on the target kit. Following these steps is a **hands-on** approach that can help make the development process with the SSP more practical, while just reading over this guide will tend to be more theoretical.

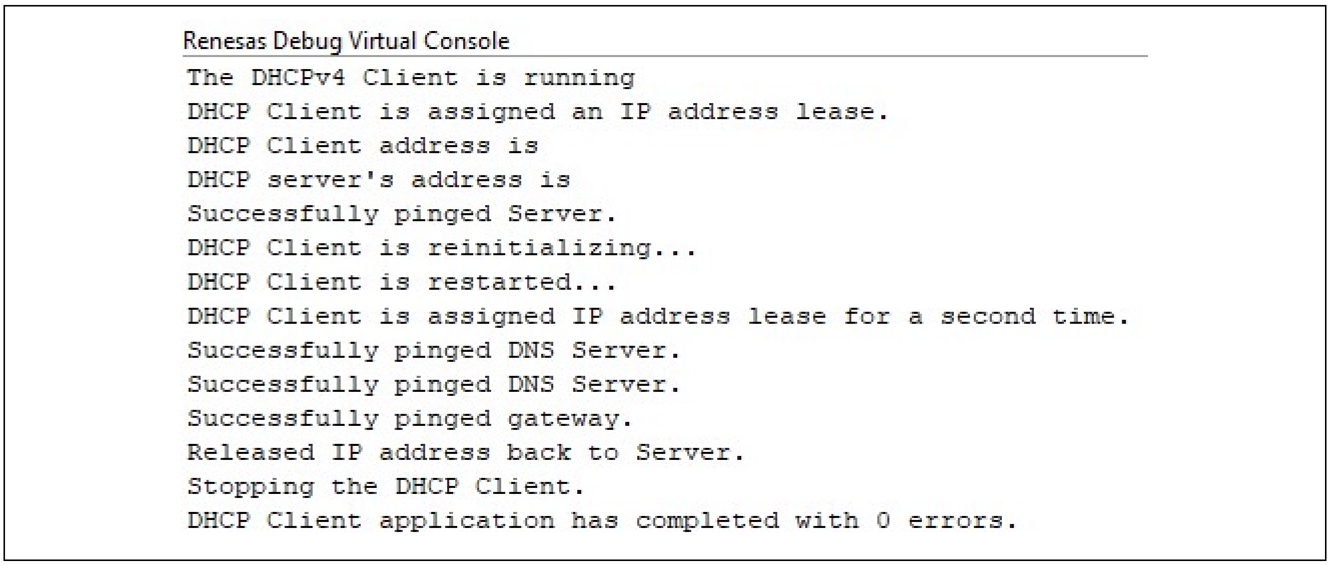
Note: The following steps are described in sufficient detail for someone experienced with the basic flow through the Synergy development process. If these steps are not familiar, refer to the first few chapters of the *SSP User's Manual* for a description of how to accomplish these steps.

To create and run the CGC Application Project, use the following steps:

1. Create a new Renesas Synergy project for the S7G2-SK called **DHCP_Client_App**.
2. Select the **Threads** tab.
3. Add a thread for the DHCP Client application and set the Name to **dhcp_thread** (to generate the `dhcp_thread_entry.c file`).
4. Set the “Stack size” property to 2048 and the “Priority” (thread priority) of this thread to 3. This thread should be lower priority than the IP instance thread for optimal performance. So, if the IP thread is set to the highest priority, e.g. 1, this application thread should be set to anything greater than 3 (the lower the priority, the higher the number).

Note that IP thread priority is set in the "IP Helper Thread Priority" property of the g_ip0/NetX IP instance component.

5. In the thread stack pane, click on the **+** icon and choose **X-Ware** -> **NetX** -> **Protocols** -> **NetX DHCP Client**.
6. Set the properties for the DHCP Client instance and the NetX Port ETHER driver.
   Make sure to set the Ethernet Interrupt Priority; its default value is disabled.
   SK-S7G2 board only: Choose Channel 1; the Channel 1 Phy Reset Pin should be `IOPORT_PORT_08_PIN_06`. These properties default to `0` and `IOPORT_PORT_07_PIN_06`.
7. Click the **Generate Project Content** button.
8. Add the code from the supplied project file, `dhcp_thread_entry.c` into the generated `dhcp_thread_entry.c` file.
9. Right click on the project and choose **New** > **Source File**.
10. Enter the name of the new source file, for example, `DHCP_client_app.c`.
11. Copy the code from the supplied project file, `DHCPv4_Client_Netx_MG.c` file into this file.
12. Right click on the project and choose **New** -> **Header File**. Enter the name of the new header file, such as `DHCP_client_app.h`. Copy the code from the supplied project file, `DHCPv4_Client_Netx_MG.h` file into this file.
13. Right click the project and choose **Build Project**
14. Right click the project and choose Debug as -> **Renesas GDB Hardware Debugging**.
15. Connect to the host PC via a micro USB cable to J19 on SK-S7G2.
16. Connect SK-S7G2 to the network running a DHCP server via ethernet cable on port J11.
17. Run the application.
18. The output can be viewed in the Renesas Debug Console:



```
The DHCPv4 Client is running
DHCP Client is assigned an IP address lease.
DHCP Client address is
DHCP server's address is
Successfully pinged Server.
DHCP Client is reinitializing...
DHCP Client is restarted...
DHCP Client is assigned IP address lease for a second time.
Successfully pinged DNS Server.
Successfully pinged DNS Server.
Successfully pinged gateway.
Released IP address back to Server.
Stopping the DHCP Client.
DHCP Client application has completed with 0 errors.
```

Figure 6. Example Output from NetX DHCP Client Module Application Project

10. NetX DHCP Client Module Conclusion

This module guide has provided all the background information needed to select, add, configure and use the module in an example project. Many of these steps (in particular preparing NetX with the required services such as enabling UDP, establishing an IP instance, and defining the driver interface for NetX) were time consuming and error-prone activities in previous generations of embedded systems. Furthermore, access to the DHCP Client element properties box simplifies customizing the DHCP Client properties, rather than tracking down the configuration options in the source code header files and manually setting their value. The Renesas Synergy Platform makes these steps much less time consuming and removes the common errors, like conflicting configuration settings or the incorrect selection of lower-level drivers. The use of high-level APIs (as demonstrated in the application project) illustrates additional development time savings by allowing work to begin at a high level and avoiding the time required in older development environments to use or, in some cases, create, lower-level drivers.

At the same time, the application project shows the use of calling DHCP Client services directly. At some point, an application may need to write the entire project directly from source code to fully customize the project to the application. That process will be much easier after working through this application project and gaining some familiarity with the NetX DHCP Client.

11. NetX DHCP Client Module Next Steps

After you have mastered a simple DHCP Client module project, you may want to review more complex examples.

Maintaining the DHCP Client when power cycling and suspending the Client

If your application requires the ability to restore the DHCP Client after the device is powered off, you would need to use the DHCP Client Restore State feature. DHCP Clients with short IP leases in particular would need to save and restore the DHCP Client record to insure timely renewal of an IP address. This application is a good example of combining the convenience of developing on the Renesas Synergy Platform with customized coding by the developer to maximize DHCP Client capabilities.

You enable this feature by setting the **Persistent client state** property to **Enabled**. Before powering off, the client record must be extracted and saved to non-volatile memory. A client record is created using this service:

```
UINT  _nx_dhcp_client_create_record(NX_DHCP *dhcp_ptr)
```

On powering up, the saved client record is restored by calling this service from the application thread:

```
UINT  _nx_dhcp_client_restore_record(NX_DHCP *dhcp_ptr, NX_DHCP_CLIENT_RECORD
*client_record_ptr, ULONG time_elapsed)
```

In some usage cases, the DHCP Client thread may only need to be suspended and resumed. To keep the time remaining on the client lease up to date, the client lease time remaining needs to be updated for the time interval that the DHCP Client thread task is suspended. To be able to do so requires **persistent client state** to be **enabled**. In this case, however, no record need be extracted of the DHCP Client, only the time remaining on the lease needs to be updated.

The services for suspending and resuming the DHCP Client thread are:

```
UINT  _nx_dhcp_suspend(NX_DHCP *dhcp_ptr)
```

```
UINT  _nx_dhcp_resume(NX_DHCP *dhcp_ptr)
```

```
The service for updating the DHCP Client lease time remaining is:
```

```
UINT  _nx_dhcp_client_update_time_remaining(NX_DHCP *dhcp_ptr, ULONG
time_elapsed)
```

Contact Renesas Synergy Support for additional details on managing the DHCP Client around power cycles and suspension of the DHCP Client.

Running the DHCP Client on a Secondary Interface

To support a secondary interface, add a NetX Source element to the project and set its Maximum Physical Interfaces property to 2 (if only one secondary interface exists). The application must then register the interface with the NetX IP instance by calling the `nx_ip_interface_attach` service. (Note that the board must have two network Ethernet connections.)

Set the interface index by calling the `nx_dhcp_set_interface_index` service before starting the DHCP Client. The NetX DHCP Client defaults to the primary interface (index = 0). The `nx_dhcp_set_interface_index` service sets the DHCP Client to the network interface specified by the index input. In the case of one secondary interface, this would be 1.

After the DHCP Client and NetX are set up for the secondary interface, the DHCP Client session is run no differently from a DHCP Client on a primary interface.

Contact Renesas Synergy Support for additional details in setting up the DHCP Client on a secondary interface.

12. Reference Information

SSP User's Manual: Available in html format in the SSP distribution package and as a pdf from the Renesas Synergy Gallery.

Links to all the most up-to-date NetX DHCP client module reference materials and resources are available on the Synergy Knowledge Base: https://en-support.renesas.com/knowledgeBase/16977452.

Website and Support

Visit the following vanity URLs to learn about key elements of the Synergy Platform, download components and related documentation, and get support.

Synergy Software	www.renesas.com/synergy/software
Synergy Software Package	www.renesas.com/synergy/ssp
Software add-ons	www.renesas.com/synergy/addons
Software glossary	www.renesas.com/synergy/softwareglossary
Development tools	www.renesas.com/synergy/tools
Synergy Hardware	www.renesas.com/synergy/hardware
Microcontrollers	www.renesas.com/synergy/mcus
MCU glossary	www.renesas.com/synergy/mcuglossary
Parametric search	www.renesas.com/synergy/parametric
Kits	www.renesas.com/synergy/kits
Synergy Solutions Gallery	www.renesas.com/synergy/solutionsgallery
Partner projects	www.renesas.com/synergy/partnerprojects
Application projects	www.renesas.com/synergy/applicationprojects
Self-service support resources:	
Documentation	www.renesas.com/synergy/docs
Knowledgebase	www.renesas.com/synergy/knowledgebase
Forums	www.renesas.com/synergy/forum
Training	www.renesas.com/synergy/training
Videos	www.renesas.com/synergy/videos
Chat and web ticket	www.renesas.com/synergy/resourcelibrary

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jun.07.17	—	Initial version
1.01	Nov.22.17	—	Update to Hardware and Software Resources Table. Editing and release.
1.02	Jan.07.19	—	Updated versions and configuration settings
1.03	May.02.19	-	Updated config file and code change for SSP 1.6.0

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