Renesas Synergy™ Platform

DK-S3A7 Ethernet Application with DM9051

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Introduction

This application note describes how to utilize the Synergy™ Software Package (SSP) Ethernet Add-on Driver to expend the network connectivity of DK-S3A7. Upon completion of this example application, you will be able to add this driver to your own project, configure it correctly for the target application, and write code using the NetX™ Network Stack. The included example project demonstrates a simple web server application as a reference and efficient starting point.

Document Scope

The following topics are covered in this document:

- Installation of Ethernet Add-on distribution
- Quick Setup for DK-S3A7 with DM9051 Demonstration Board
- Using NetX Application Layer Modules with Ethernet Add-on driver
- Running the Example Application

Target Device

DK-S3A7

PC Recommendations

- A PC running Windows® 7 (32-bit, 64-bit), Windows® 10 (32-bit, 64-bit) with the following Renesas Synergy™ Software installed:
  - — e^2 studio ISDE version: 5.3.1.002 or IAR Embedded Workbench® for Renesas Synergy™ v7.71.1
  - — Synergy Software Package (SSP) 1.2.0 or SSC (Synergy Standalone Configurator) 5.3.1
- A PC with a USB 2.0 port and connection to the target board with an Ethernet cable

Required Resources

To build and run the example application, you need:

- DK-S3A7 Version 2.0 or later
- DM9051 Demonstration Board Version 2.1 or later (For the Asia region, you can purchase this item through the TaoBao online shop. Otherwise, you can contact with Davicom Semiconductor directly through the email sales@davicom.com.tw)

Contents

1. Installation information of the Ethernet Add-on Driver

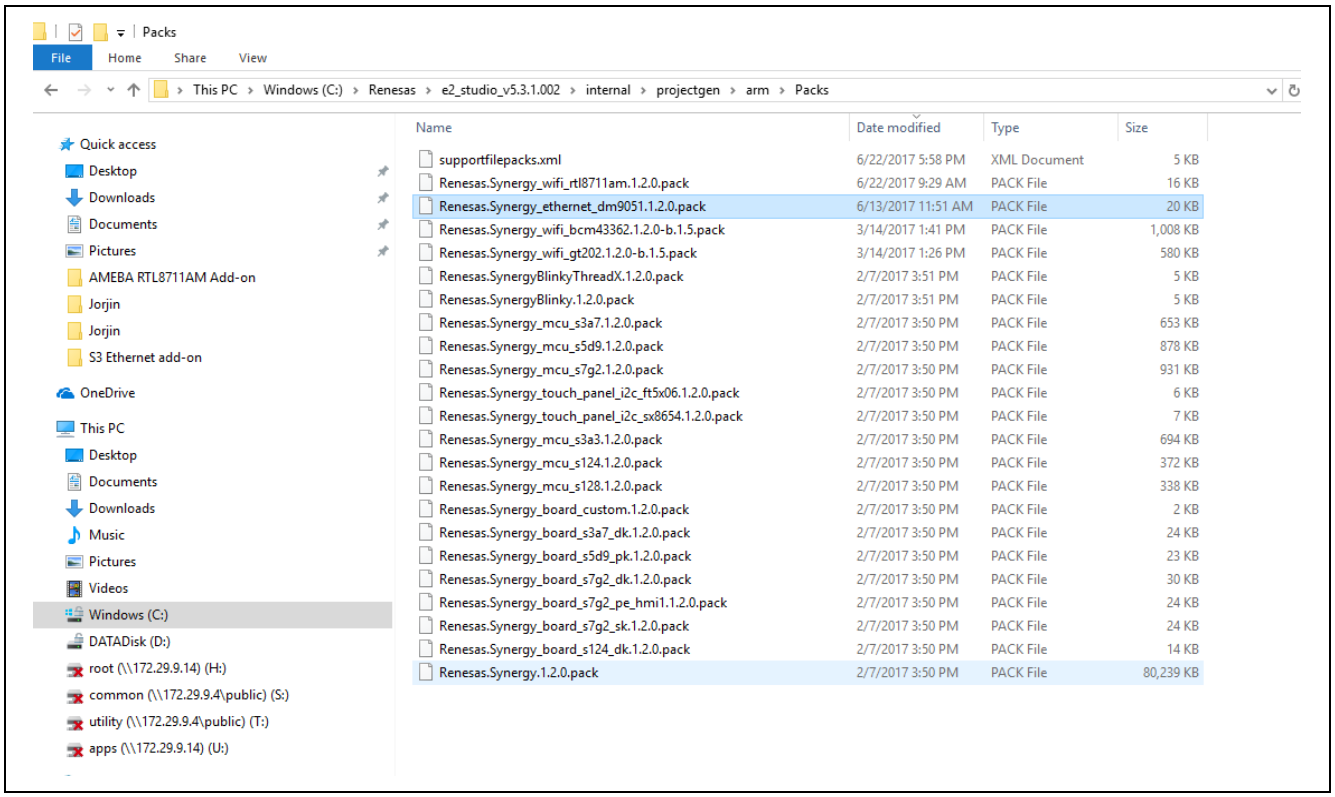
1.1 Installation

The steps to install the distributions are as follows:

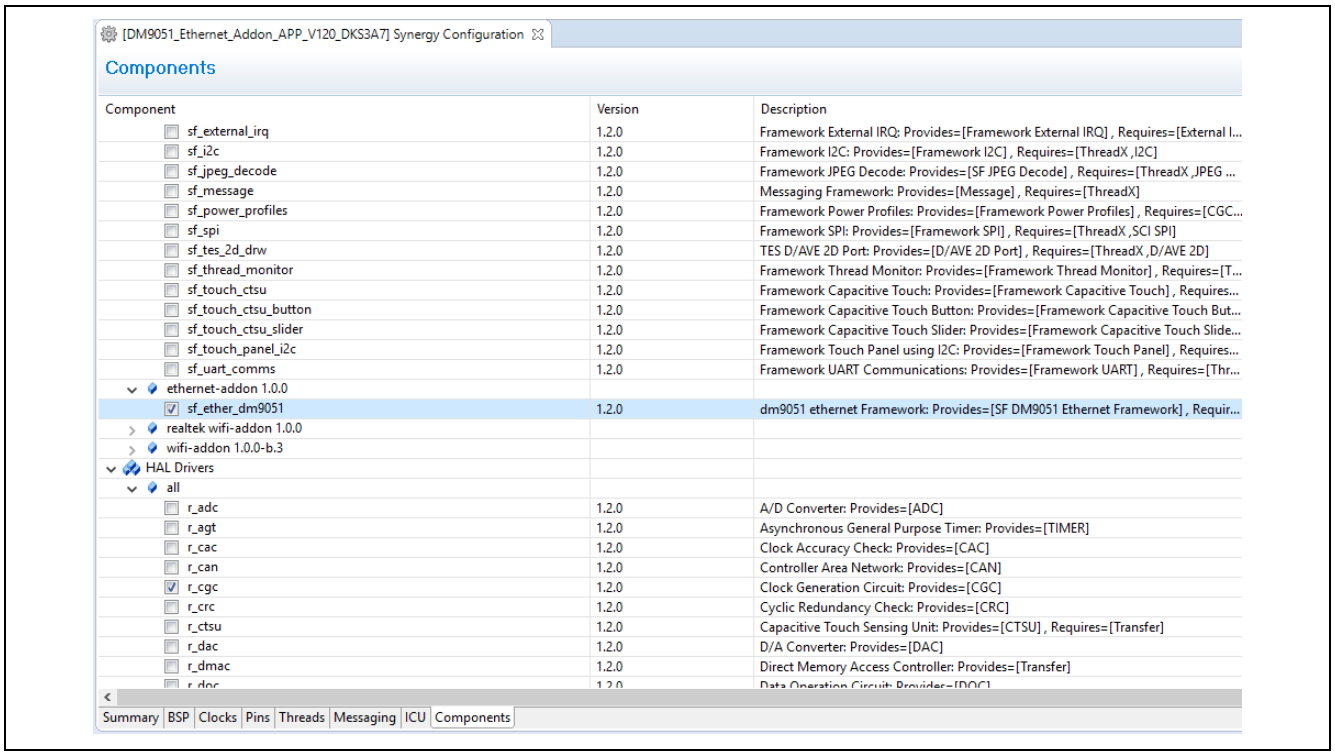
1. Check that SSP v1.2.0 has been installed
   Note: The default installation folder for the SSP is `C:\Renesas\e2_studio`
2. Download the Ethernet Add-on pack from the Renesas Synergy™ Gallery (https://synergygallery.renesas.com/)

Note: The file is located in the Davicom's project, that is under the Partner Showcase of the Synergy Gallery.

3. Open the SSP Packs folder following the directions below. The SSP Packs folder is under the e2_studio folder
   e2_studio → internal → projectgen → arm → Packs
4. Manually copy and paste the **Ethernet Add-on pack** into the **Packs** folder as shown in the picture below.



5. After the previous processes are done, you should be able to see an available Add-on component in the Synergy configurator shown below.



1.2 Release information and compatible tools

Release Module Name	Version	Description
DM9051 Ethernet Add-on module	1.0.0	This Ethernet Add-on pack is based on the SSP version 1.2.0

Tools	Version	Description
e^2 studio	5.3.1	ISDE software development environment
GNU ARM Compiler	4_9-2015q3	GNU ARM® compiler GCC_4.9.3.20150529
IAR Compiler	7.71.1	IAR ARM® compiler toolchain

2. Quick Setup for DK-S3A7 with DM9051 demonstration board

2.1 DM-9051 demonstration board

Connect the Davicom DM9051 Demo Board to the PMODA connecter on the DK-S3A7. The DM9051 Demo Board can't be plugged into the PMODA connector directly because the interrupt pins are not available on any of the PMOD connectors on the DK-S3A7 v2.0 board. You need to connect pin 2 of DM9051 Demo Board to pin P5_6 of port pin header J9 on the DK-S3A7 board. See the table below, for the DM9051 Demo Board connections to PMODA on DK-S3A7 board.

Table 1 DM9051 Demo Board connections to PMODA on DK-S3A7

DM9051 Demo Board (J1) header pin #	PMODA header pin#	Description
1	1	Chip Select (Port 4 Pin 11)
3	2	SPI MOSI (Port 4 Pin 9 MOSI3_A)
5	3	SPI MISO (Port 4 Pin 8 MISO3_A)
7	4	SPI CLK (Port 4 Pin 10 SCK3_A)
9	5	GND
11	6	VCC
2	NC	This interrupt request pin of DM9051 should be connected to an IRQ pin of S3A7. In this App-Note, we use P5_6(IRQ15) to get interrupt request.
4	8	Not Connected
6	9	Not Connected
8	10	Not Connected
10	11	Not Connected
12	12	Not Connected

Note: Make sure that 3.3 volt is selected for PMODA

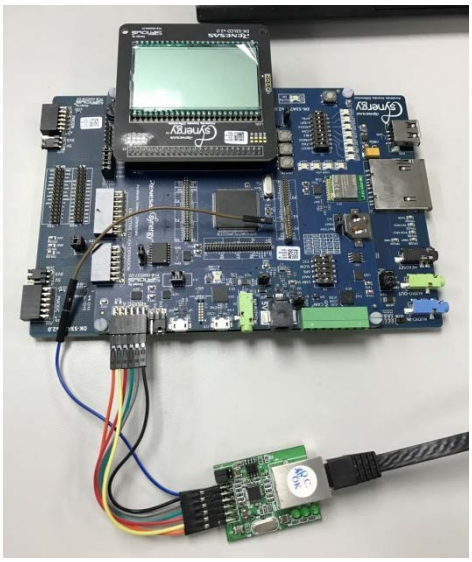


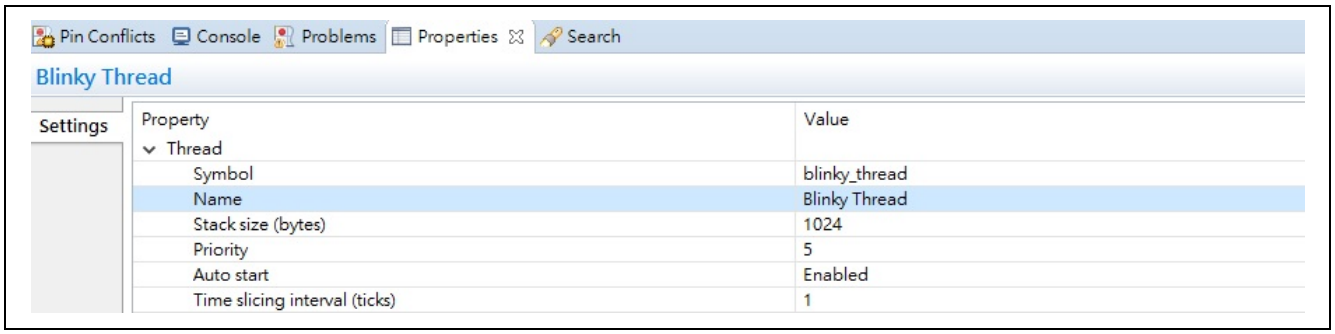
Figure 1 Shows the DM9051 Demo Board connected to the PMODA connector on the DK-S3A7

2.2 Configuring Ethernet Add-on components

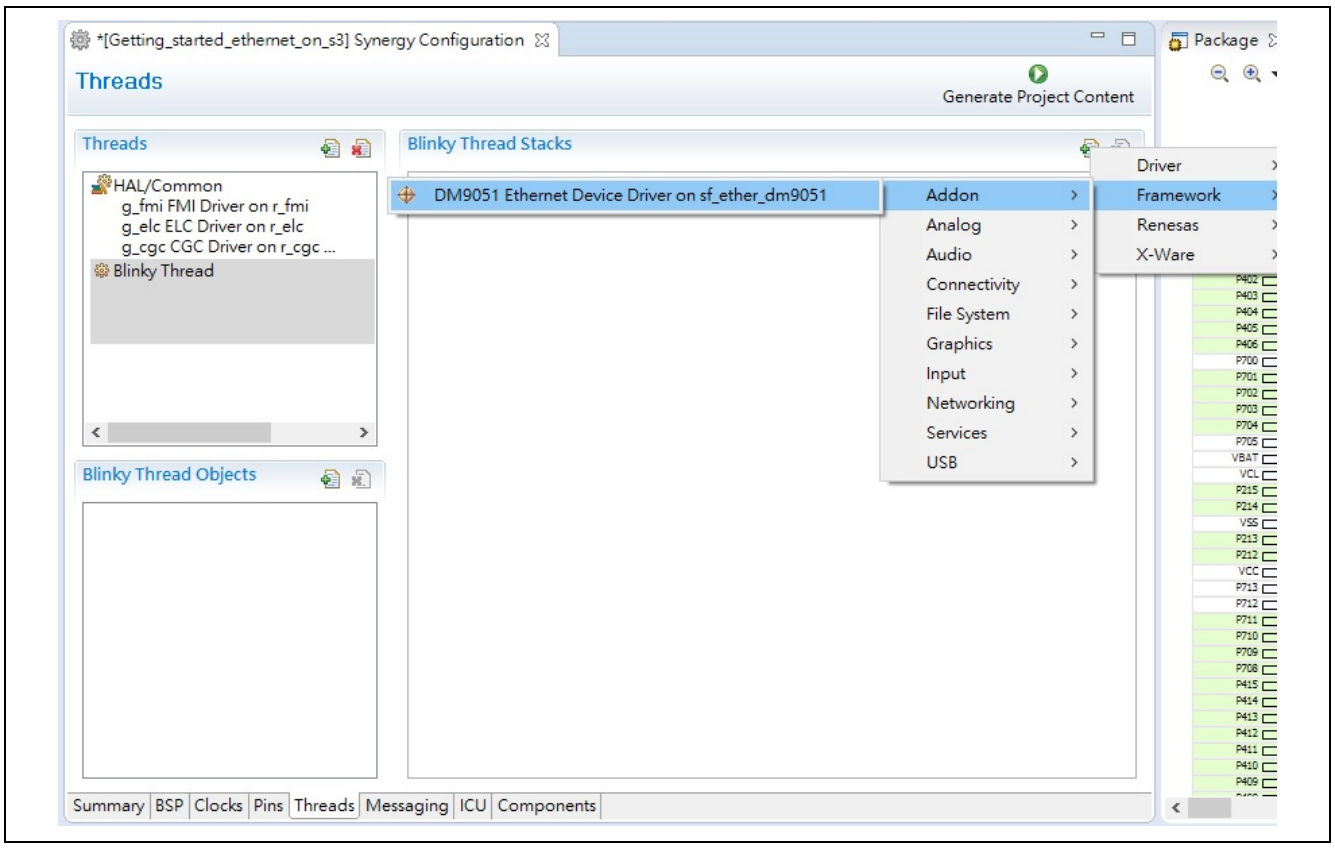
The following instructions list the common steps in creating an e^{2}studio project with an Ethernet Add-on.

1. Start the Synergy Project wizard in e^{2}studio by clicking **File > New > Synergy Project**.
2. Choose SSP version 1.2.0 or later
   A. Choose **S3A7 DK** as the board

3. Create a project with your desired Project template.
   A. Choosing **Blinky** with ThreadX® gives you a project with ThreadX already added.
4. Go to the Threads tab.
5. Add a thread to the system if one is not already present.
   A. Use the **Blinky** thread, that is already created.

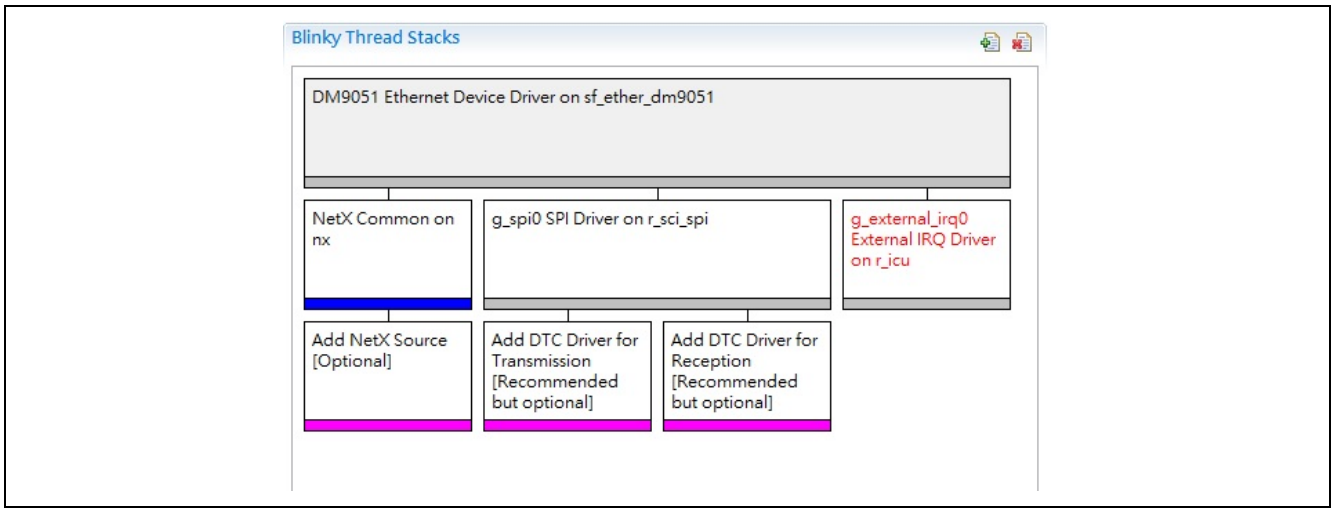


6. Add the Add-on module through the **New Stack** > **button**.
   A. You can find the Add-on module that is named DM9051 Ethernet Device Driver, through the **Addon** > **Framework** menus.



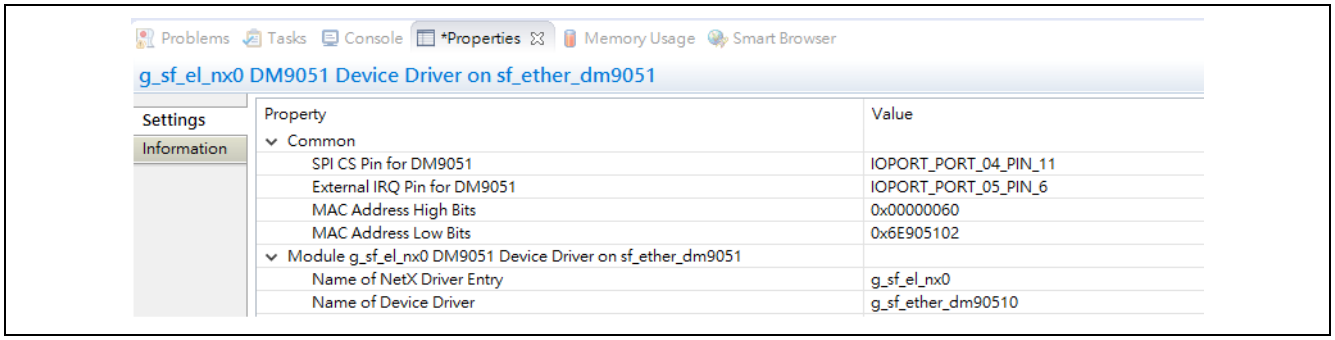
7. Add the SPI Driver on `r_sci_spi` under DM9051 Ethernet Device Driver.
   Note: Make sure to remove the DTC driver for transmission and reception.

8. Thread pane setup:
   A. After the previous steps are completed, the **Blinky Thread Stacks** pane should be the same as below.



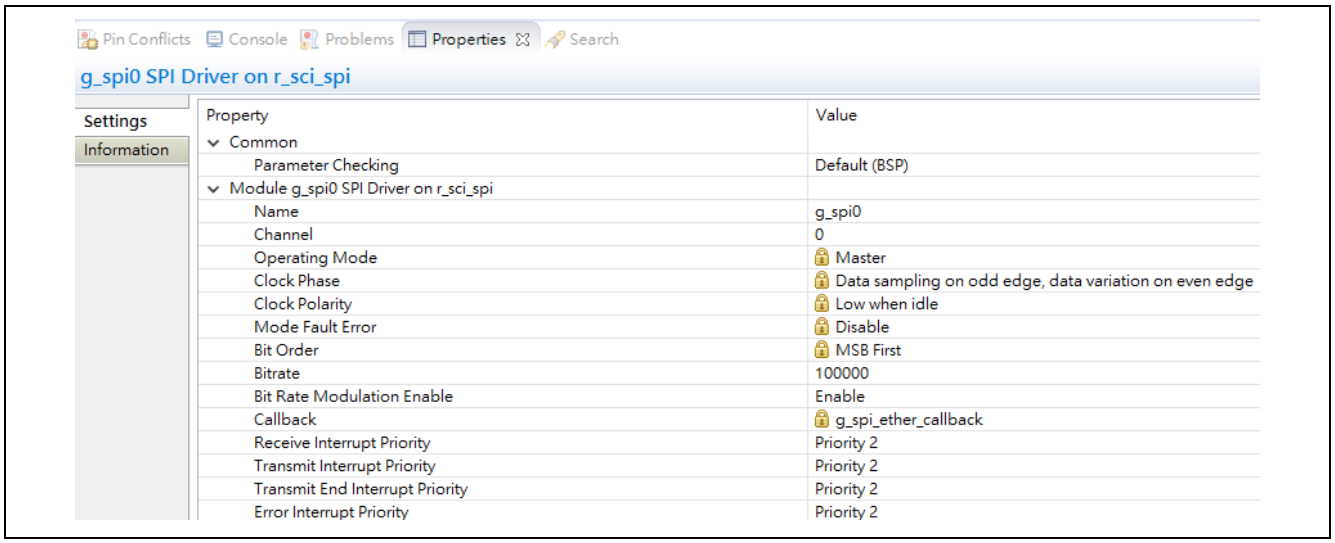
   B. Configure the Properties of the DM9051 Ethernet Device Driver.

Note: Following the DM9051 Demo Board connections, Port 4 Pin 11 is set for SPI CS of DM9051, and Port 5 Pin 6 is set for Interrupt Request of DM9051.



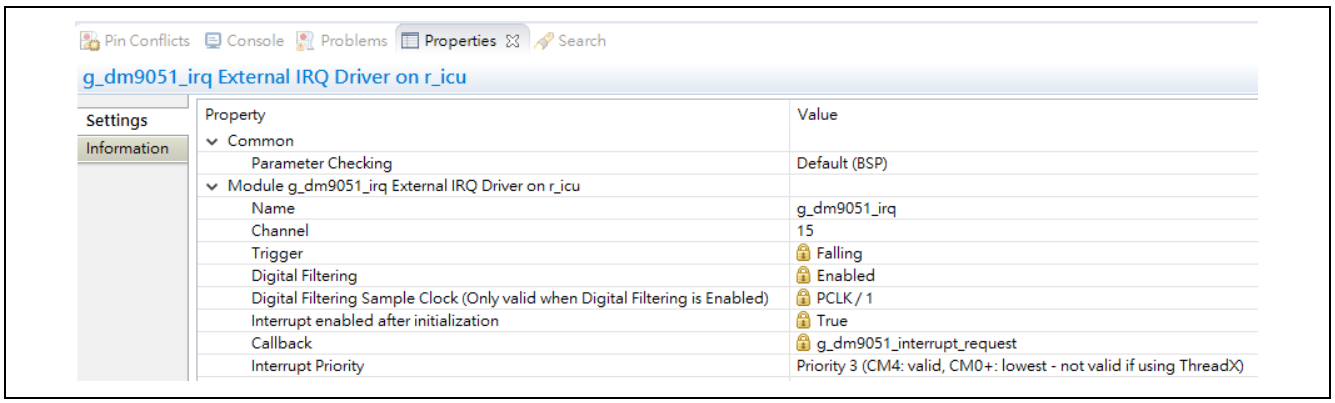
   C. Configure the property of SPI Driver on `r_sci_spi`.

Note: For DM9051, the maximum clock frequency of SPI is 50 MHz. Here, we use 10 MHz for the current implementation.

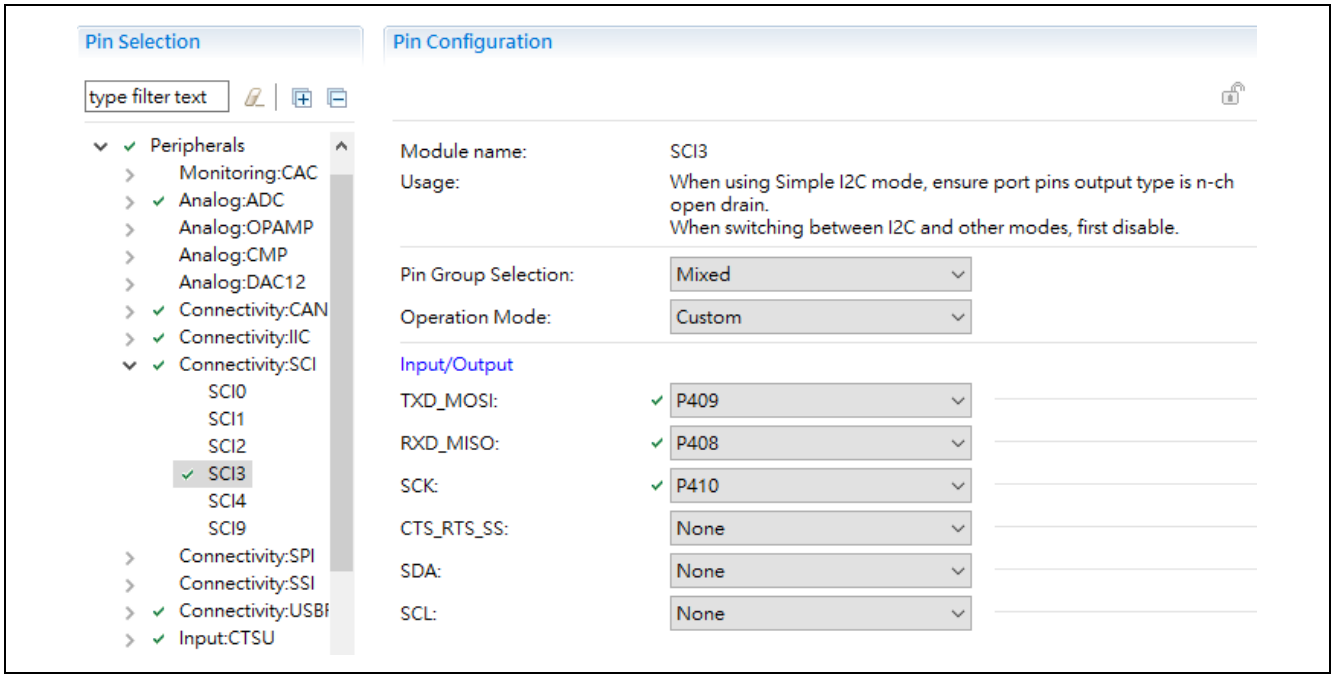


D. Configure the property of **External IRQ Driver** on `r_icu`.

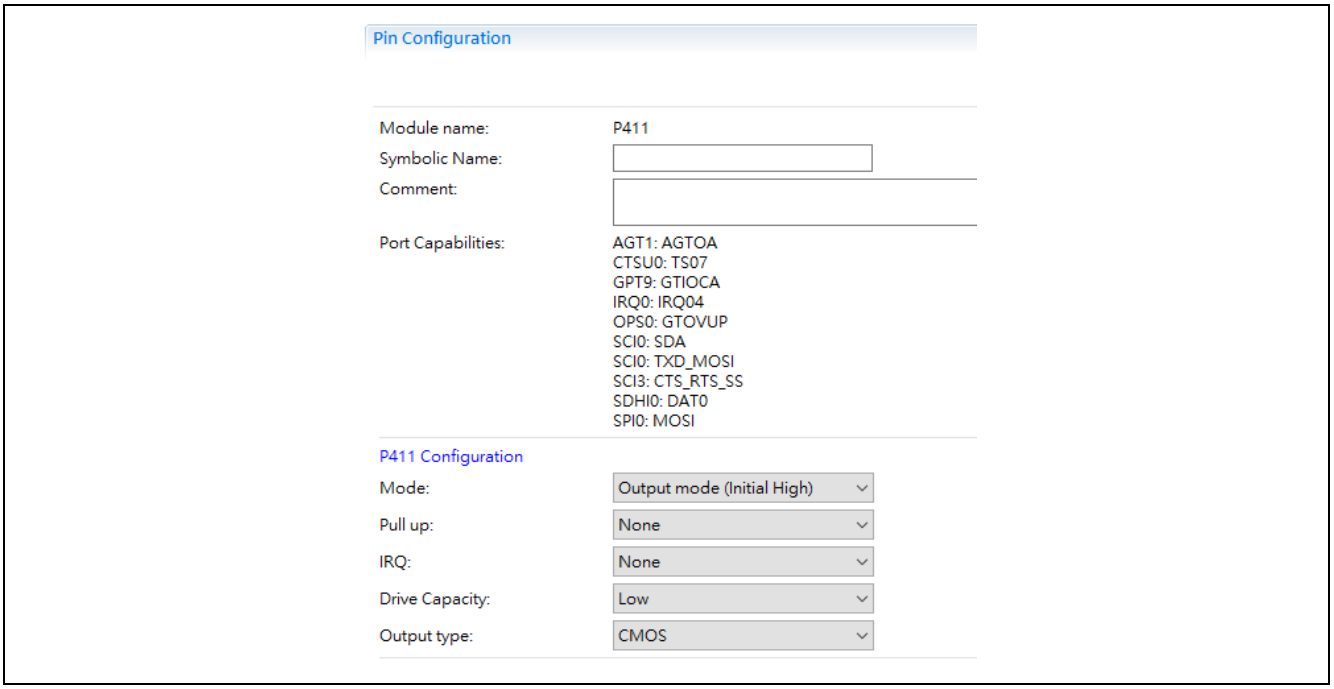
Note: For the DM9051 Demo Board connections, the external IRQ pin is Port 5 Pin 6, that supports the IRQ channel 15.



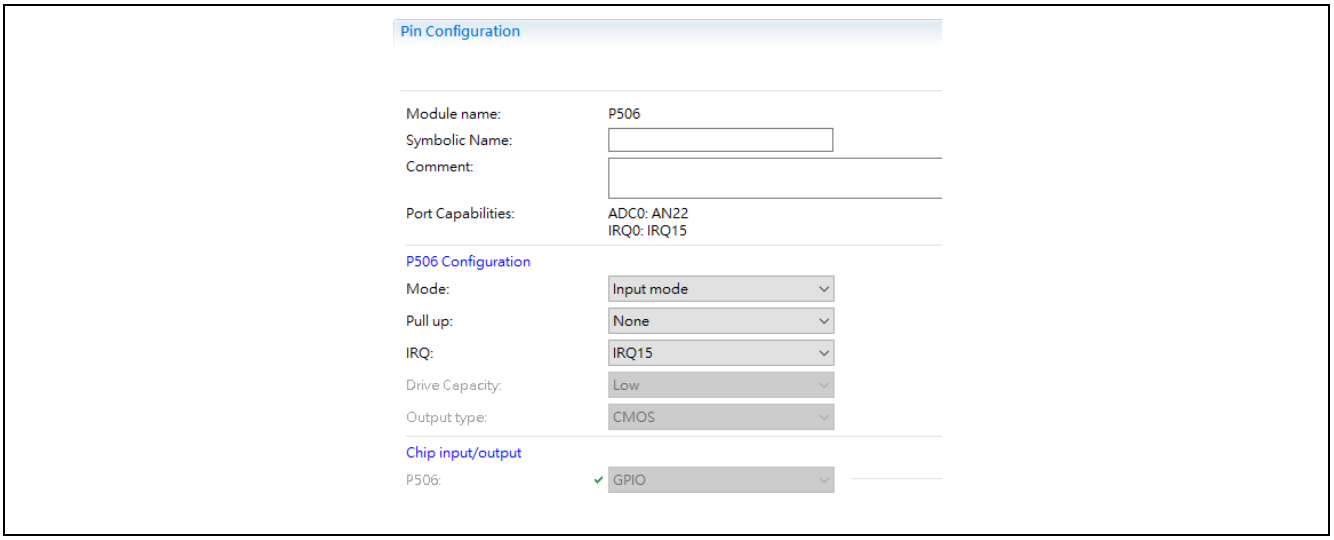
9. SPI Pin configurations:
   A. For DK-S3A7 on PMODA, use **SCI3**.
   B. From the **Pins** tab, go to the **Pin Selection** section.
   C. Go to **Peripherals > Connectivity:SCI > SCI3**
   D. Set SCI3 up in **Custom** operation mode. Set up P409, P408, and P410 for SCI SPI use.



10. SPI Chip-Select in configurations:
    A. From the **Pins Configuration** tab, go to the **Pin Selection** section.
    B. Go to **Ports** > **P4** > **P411**



11. Set up the **IRQ pin P5_6** for **DK-S3A7**, which is **IRQ15**:
    A. From the **Pins tab**, go to the **Pin Selection** section
    B. Go to **Ports** > **P5** > **P506**



Note: For IAR EW for Synergy, the Ethernet Add-on component can be configured by the Synergy Standalone Configurator (SSC) and the configuration steps are the same as described above.

3. Writing an Application with the Ethernet Add-on Driver

As shown in the figure below, the DM9051 device driver is fully integrated with the NetX Network stack inside the SSP, so users can easily extend the Ethernet connectivity on Synergy S3, but also leverage the NetX Network stack to develop the Network application. In this section, we will introduce in detail how to utilize DM9051 Add-on driver by using the NetX API calls or the NetX Application Layer Modules.

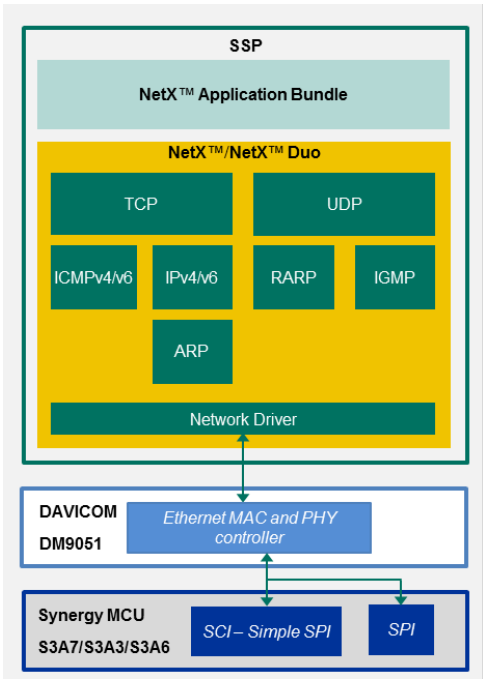


Figure 2 Infrastructure of NetX application implementation with DM9051 Add-on Driver

3.1 Using NetX API Calls

Each IP instance in NetX has a primary interface network driver specified by the application in the `nx_ip_create` service. Each IP instance has a helper thread, which is responsible for handling all deferred packet processing and all periodic processing. The first processing in an IP creation is to call the `nx_ip_create` service, and this service will start the network driver initialization and start an endless loop to process packet and periodic requests after the initialization is completed. To utilize this service, we look up its description in *NetX User's Manual* as shown below and it's easy see that there is a required input parameter, which is a user-supplied network driver. That's where we are going to add a DM9051 driver entry function, which is defined in DM9051 Add-on driver.

nx_ip_create

Create an IP instance

Prototype

```
UINT nx_ip_create(NX_IP *ip_ptr, CHAR *name, ULONG ip_address,
                  ULONG network_mask, NX_PACKET_POOL *default_pool,
                  VOID (*ip_network_driver)(NX_IP_DRIVER *),
                  VOID *memory_ptr, ULONG memory_size,
                  UINT priority);
```

Below is a snippet of sample code that demonstrates how to create an IP instance and enable the application protocols by using the NetX APIs with DM9051 Add-on Driver.

```
/* Network Thread entry function */
void network_thread_entry(void)
{
    /* TODO: add your own code here */
    UINT  status;
    ULONG actual_status;

    nx_system_initialize();

    status = nx_packet_pool_create(&g_packet_pool0, "NX Packet Pool", 2048,
                                   &g_packet_pool0_pool_memory[0], (16 * 2048));
    APP_ERR_TRAP(status)

    status = nx_ip_create(&g_ip, "NX IP Instance",
                          (IP_ADDRESS(192,168,1,90)), (IP_ADDRESS(255,255,255,0)),
                          &g_packet_pool0, g_sf_el_nx0,
                          &g_ip0_stack_memory[0], 2048, 3);
    APP_ERR_TRAP(status)

    status = nx_arp_enable(&g_ip, mem_arp, sizeof(mem_arp));
    APP_ERR_TRAP(status)

    status = nx_tcp_enable(&g_ip);
    APP_ERR_TRAP(status)

    status = nx_icmp_enable(&g_ip);
    APP_ERR_TRAP(status)

    status = nx_ip_interface_status_check (&g_ip, 0, NX_IP_INITIALIZE_DONE,
                                           &actual_status, NX_WAIT_FOREVER);
    APP_ERR_TRAP(status)
}
```

Note: The `g_sf_el_nx0` is a name of the DM9051 driver entry function. Once you select the module of **DM9051 Device Driver on sf_ether_dm9051** in the Synergy Configurator, the name of the DM9051 driver entry can be configured in the below properties window.

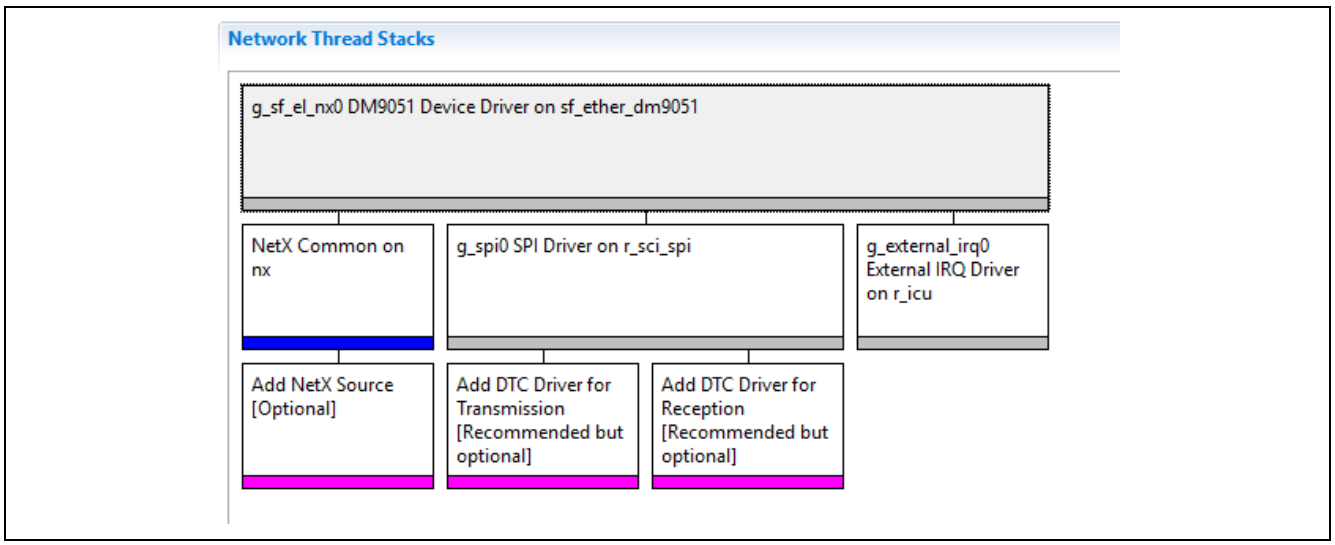


Figure 3 The module view of DM9051 Device Driver on sd_ether_dm9051

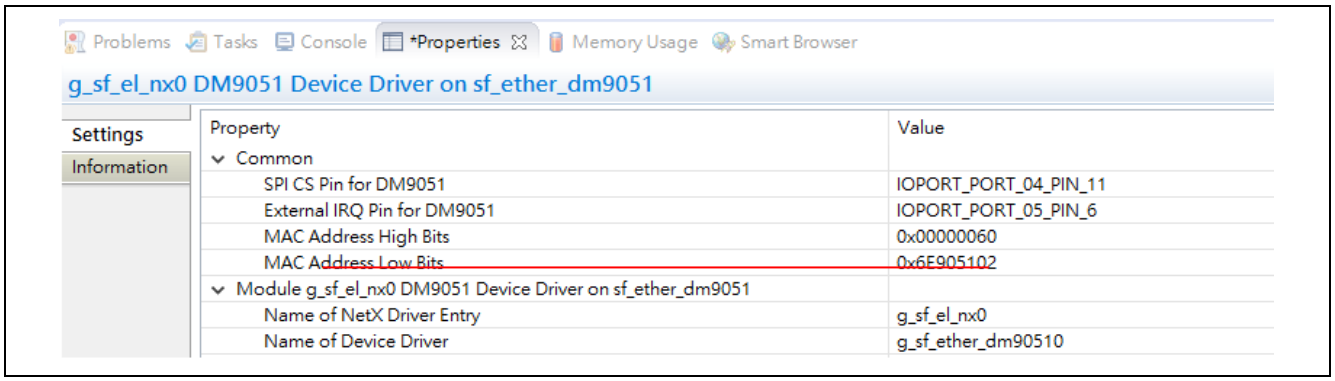
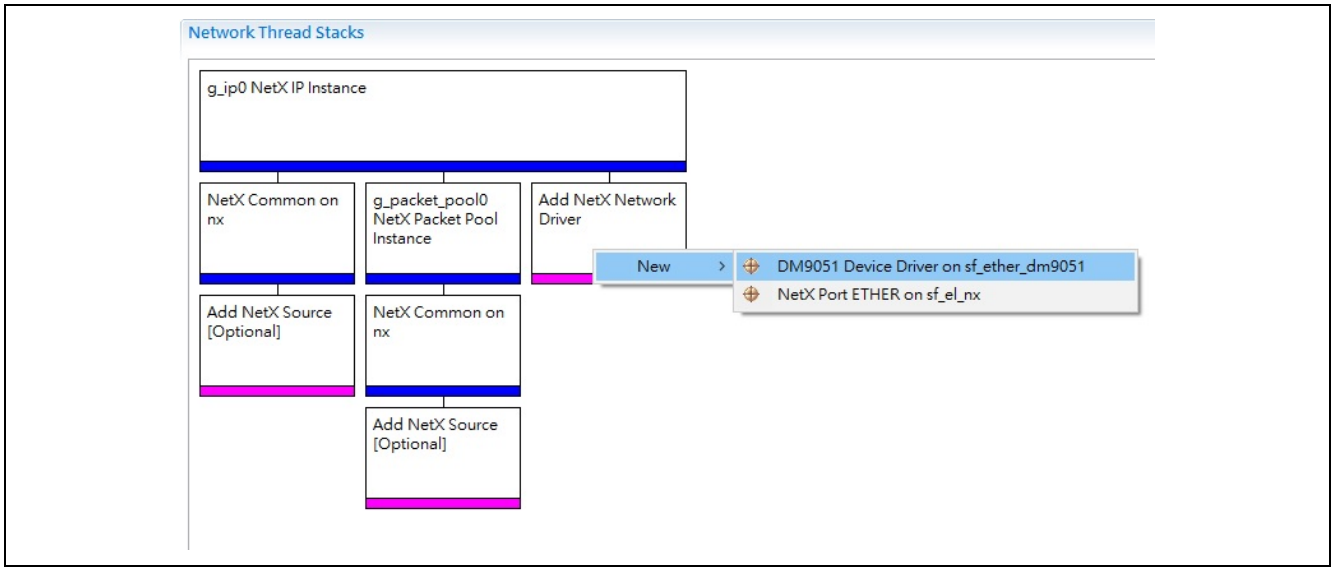


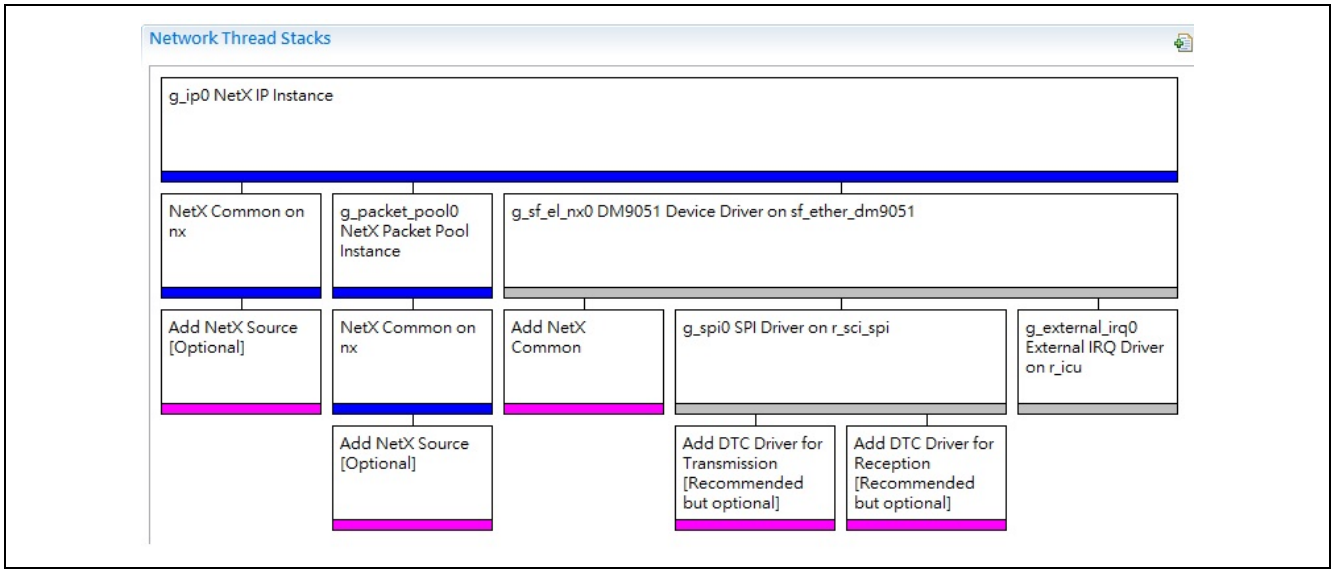
Figure 4 The configurable properties for DM9051 Device Driver on sd_ether_dm9051

3.2 Using NetX Application Layer Modules

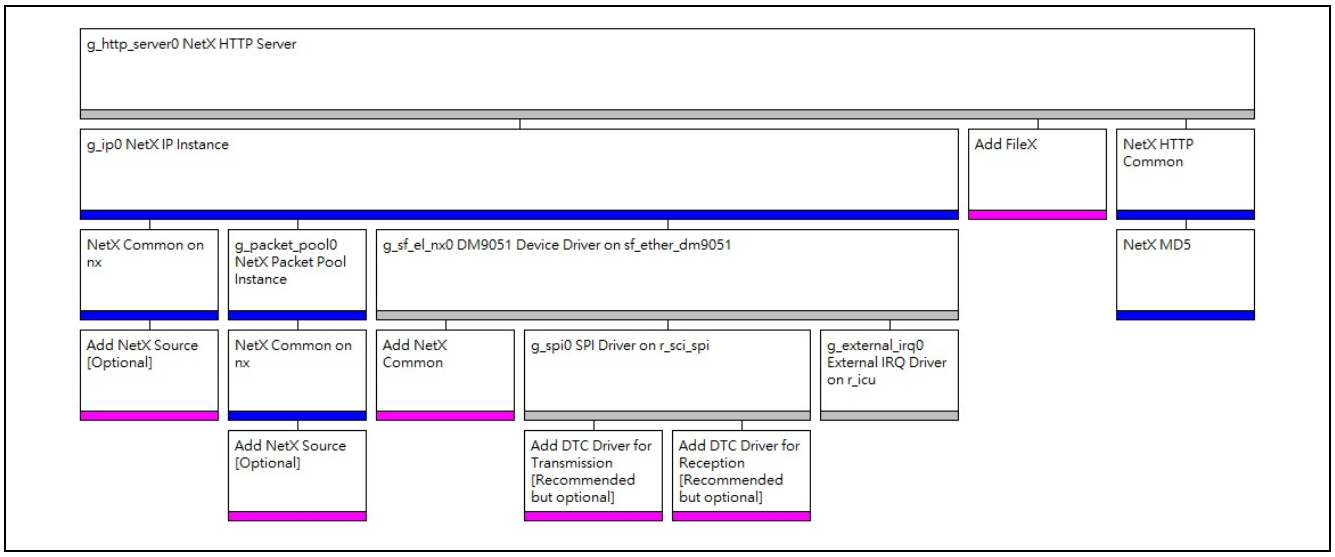
In the SSP v 1.2.0, NetX and NetX Application Layer modules are integrated into the SSP. To use these modules with the DM9051 Device Driver, add the DM9051 Device Driver module as a NetX Network Driver under NetX IP instance module. The following pictures show the common steps in using NetX Application Layer modules with the Ethernet Add-on module.



Configure the DM9051 Device Driver like the steps we did in section 2.2.



After a NetX IP instance is created, we can use it to establish NetX Application Layer modules, such as HTTP, DHCP and others.



4. Application Example of an Ethernet Add-on

4.1 Importing, configuring, and building the project

Before you can run this example application, you must change the default IP address for the application in the ISDE configurator to the IP addresses that are appropriate for your network and PC. The following steps describe how to import, configure, change the default IP address in the application to an IP address appropriate for your network, and then build the project:

1. Follow the procedure in the *Synergy Project Import Guide* to import the project into the e^2 studio ISDE. Do not build the project.
2. Open the `configuration.xml` for the project, select the **Threads** tab, and choose **Network Thread**. Click on **Module g_ip0, NetX IP instance**, on the **Properties** window, and change the IPv4 address to the one that is in the same domain of the PC and is not being used. In this application, the default setting of IP address for the board is chosen as 192.168.1.90.

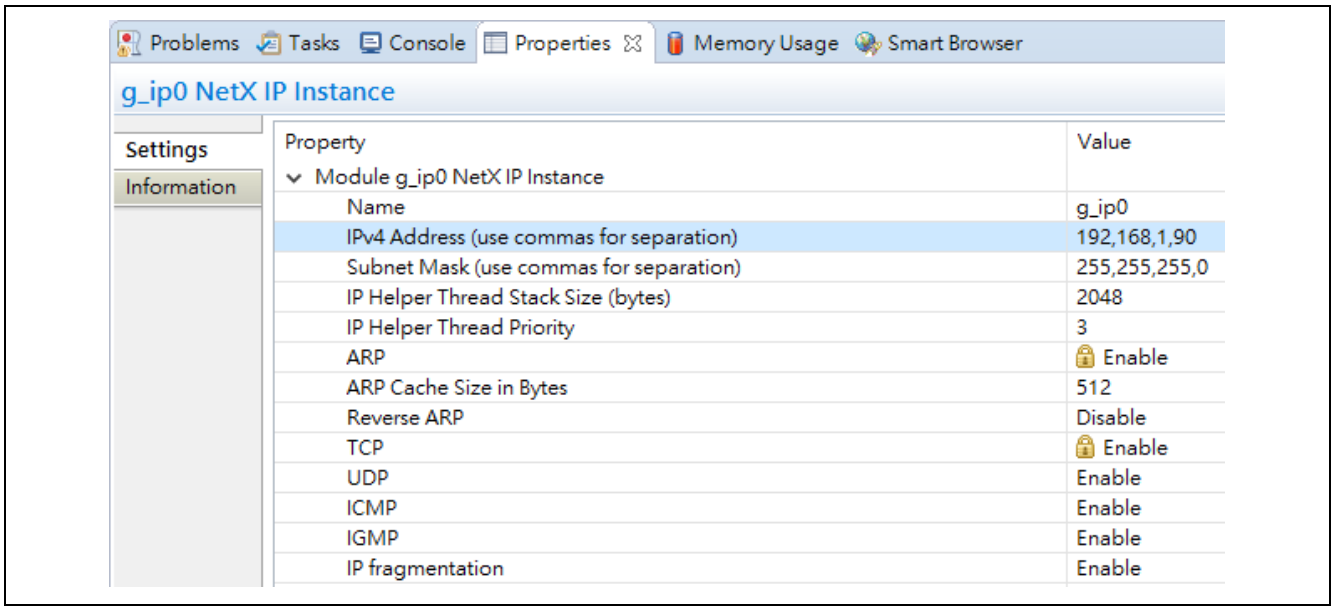


Figure 5 The properties view of NetX IP instance module

3. After selecting an IP Address for the board, you should also configure a static IP address for your Ethernet Port of your PC. The processes are shown as below.

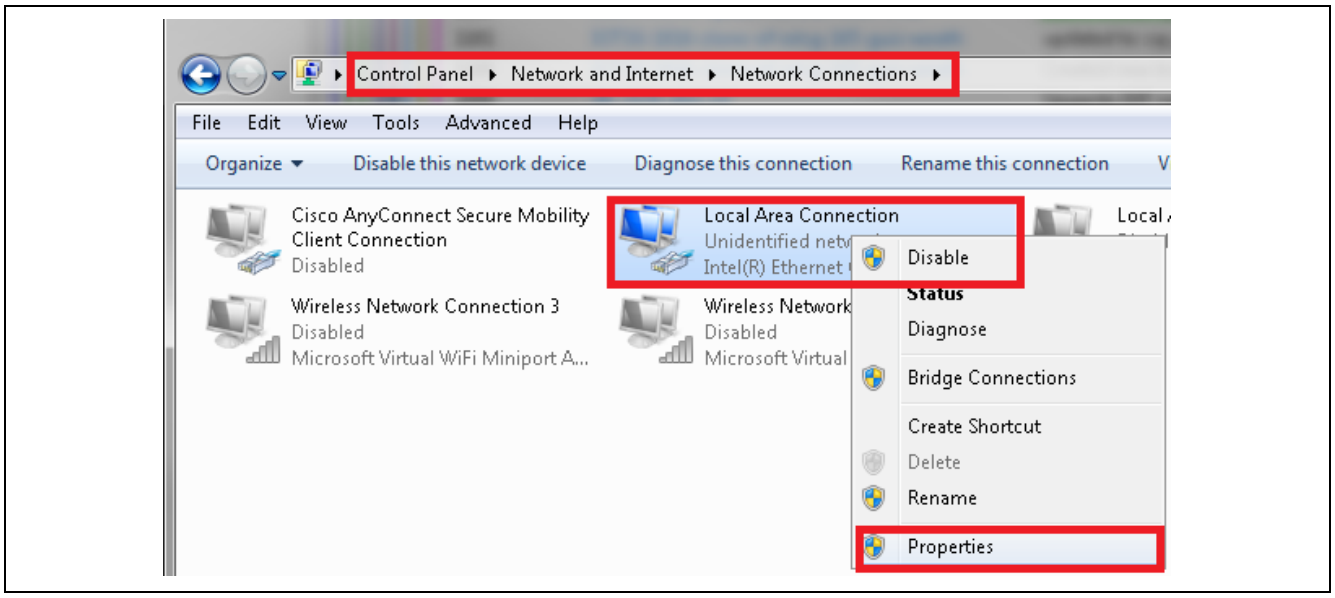


Figure 6 Configure the Ethernet port of your PC to the static IP address to test the board

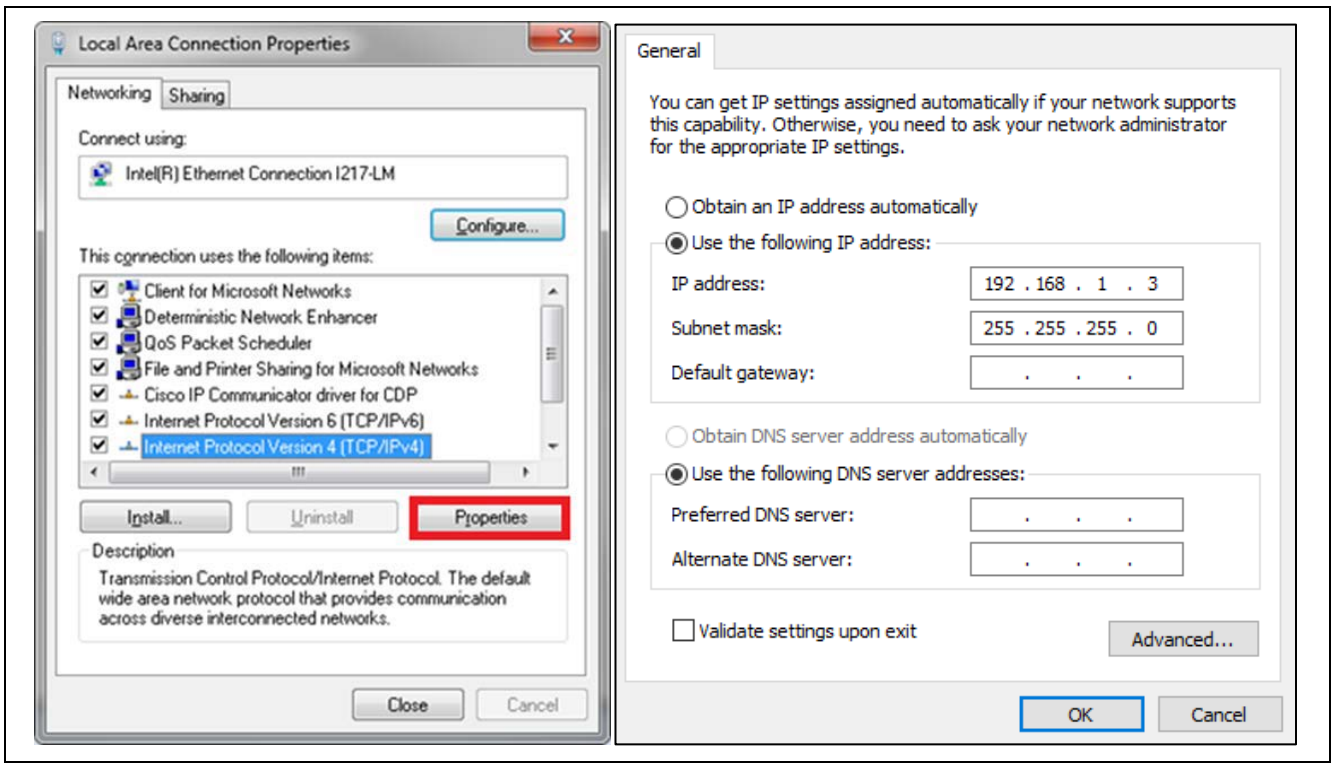


Figure 7 Static IP address for the Ethernet port of the PC

A. Follow the procedure in the *Synergy Project Import Guide* to build and debug the project. When prompted to select the debug configuration, select **Ethernet_Addon_Application_V120_DK_S3A7 Debug** (under Renesas GDB Hardware Debugging).

4.2 Running the Application Example

The application example implements a simple web server application on a DK-S3A7 board using the DM9051 Add-on module, SSP and the NetX network stack. For being able to run the application on the DK-S3A7, you need to configure two DIPSWs by the following steps.

Step 1: Enable the PMOD connector of the DK-S3A7 board by setting the DIPSW S5 PMOD switch to ON.

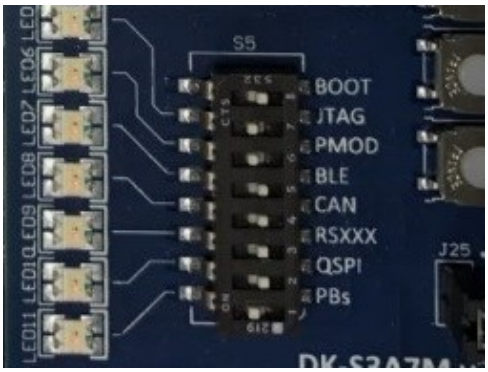


Figure 8 The setting of DIPSW S5 for the DK-S3A7

Step 2: Enable the USB Host connector of the DK-S3A7 board by setting the DIPSW S6 USBF switch to OFF.

Figure 9 The setting of DIPSW S6 for the DK-S3A7

The NetX HTTP Server is designed for use with the FileX® embedded file system, and we use the USB Drive to store the HTTP files in this application. You need to insert the USB Drive into the USB connector (USB Mass storage) as shown in the figure below, before you start to run the application.

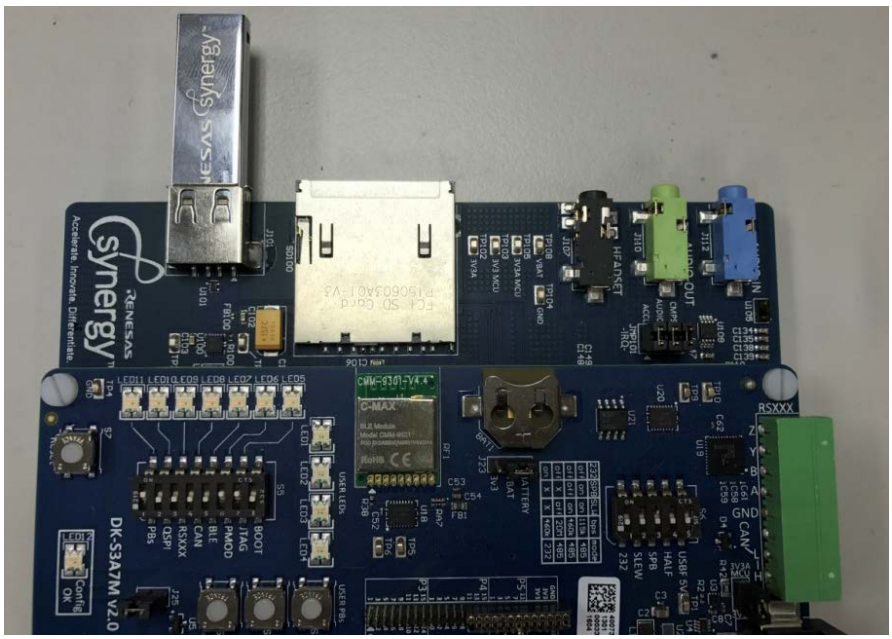


Figure 10 USB Drive connection for the DK-S3A7

To run the example web server application:

1. In a Command Prompt window on your PC, enter the **ping** command with the IP address that you specified for the board (192.168.1.90). In the following example, the ping result for the board address is shown in the following figure. If the connectivity and configurations are proper, you will see the ping working.

```
C:\Users\cpchan>ping 192.168.1.90

Pinging 192.168.1.90 with 32 bytes of data:
Reply from 192.168.1.90: bytes=32 time=3ms TTL=128
Reply from 192.168.1.90: bytes=32 time=2ms TTL=128
Reply from 192.168.1.90: bytes=32 time=1ms TTL=128
Reply from 192.168.1.90: bytes=32 time=2ms TTL=128

Ping statistics for 192.168.1.90:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 3ms, Average = 2ms

C:\Users\cpchan>_
```

Figure 11 Ping results

2. In the URL text field of your web browser, enter the IP address that you used with the ping command in the previous step. You should see the view in the figure below.

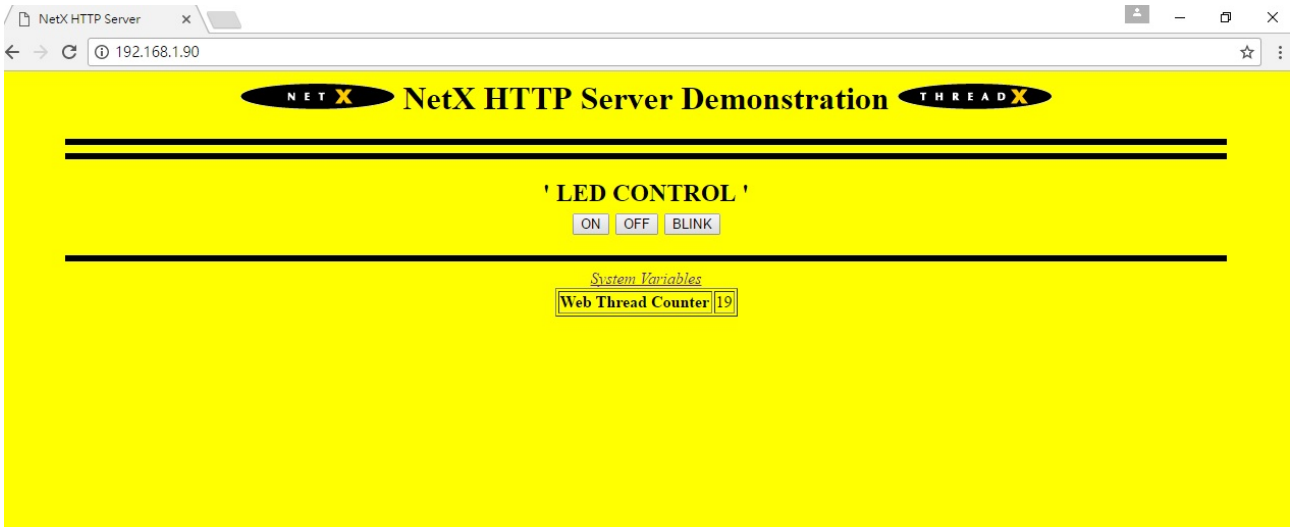
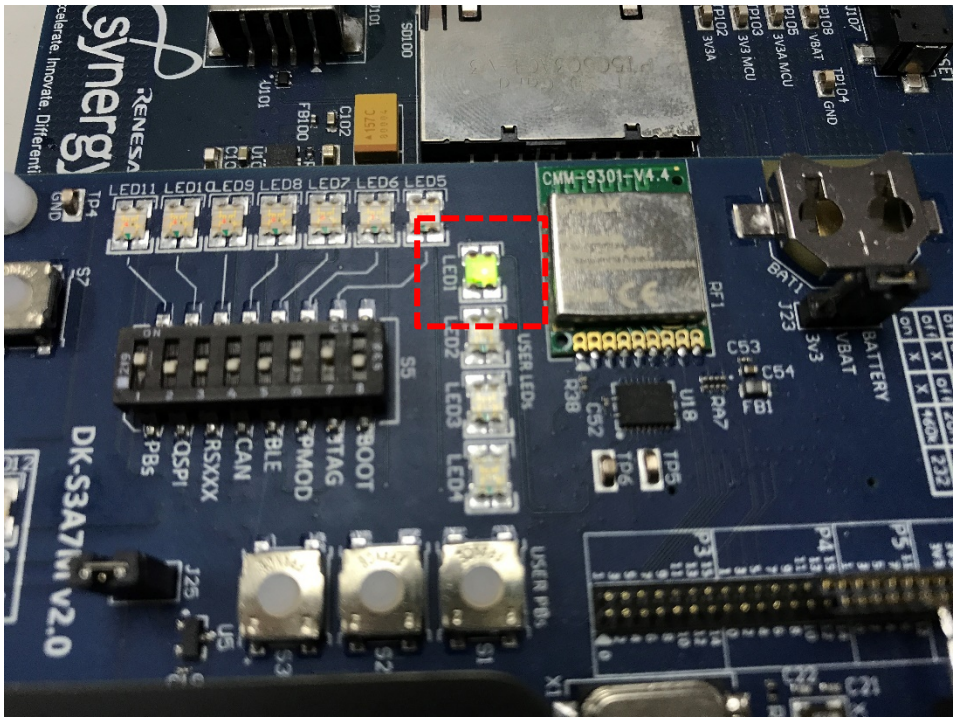


Figure 12 HTTP Web page

3. In the web page, you can control the status of LED1 on the DK-S3A7 board by clicking the web buttons, that are ON, OFF and BLINK.



4. Click the **Terminate** button to close the debugger.

5. DK-S3A7 Ethernet Add-on Application Implementation Details

In this section, the implementation details of DK-S3A7 Ethernet application are described. The Ethernet application is created on top of the NetX Webserver application, that is available for the DK-S7G2, SK-S7G2, PK-S5D9, and PE-HMI boards . One of the reasons for choosing the NetX Webserver application is to showcase the modular approach for adding a new application on top of the existing application. The DM9051 Add-on Module satisfies NetX driver function requirement and uniform interface of NetX IP Instance Module to be able to move the NetX application from other devices to the DK-S3A7 without changing the application. As shown in the figure below, the Webserver application consists of the Network thread, Web thread, and the USB thread. A few modifications have been done on the web page

layout. Thread1 to Thread7 are removed to simplify the project. The relative thread counters, that are **thread_1_counter**, **thread_2_counter**…, have also been removed to simplify the display parameters of web page. The LED control thread is added to implement IO control through HTTP web interface.

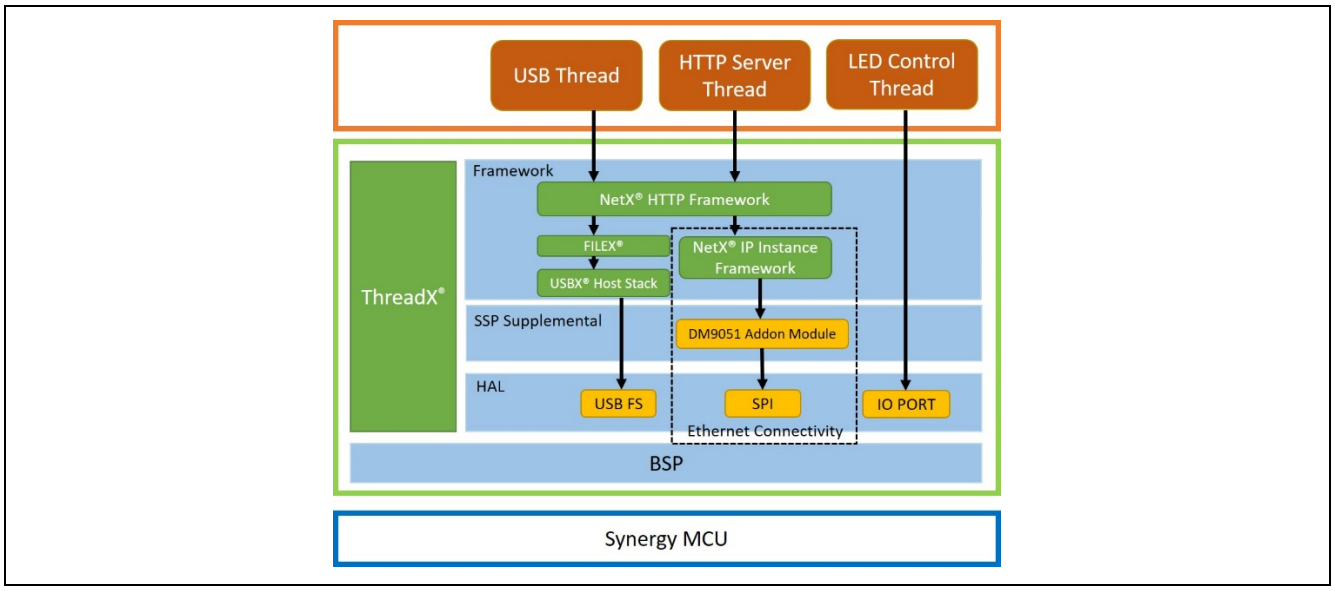


Figure 13 Architecture of the NetX Webserver application on the DK-S3A7 board

The details of the NetX Webserver application for the DK-S3A7 and its thread are given in the following sections.

5.1 HTTP Server Thread

This thread module along with the Synergy Configurator generated code, brings in the HTTP server creation, with the TCP/IP core stack. It also brings the USBX Host Mass Storage Stack and DM9051 driver add-on. This thread is responsible for the HTTP server, Ethernet Connectivity, and executing the user code.

The configurator generated code is part of the `common_data.c/h` and `http_server_thread.c/h` under the `src/synergy_gen` folder. The code, under these files, are a common code specific to the thread's selected module stack components. In this case, the common code related to NetX is available under the `g_comm_init()` function. In the common code, the NetX driver entry function, packet pool creation for the DM9051 driver module is also available as part of the configurator created code.

In the user application code `src/http_server_thread_entry.c` it waits for the USB device to be inserted, updates the previously created FileX media instance for NetX HTTP Server Media Pointer, that starts the HTTP Server and resumes the LED Control Thread.

In the SSP v1.2.0, this will be configurator created, along with FileX media pointer for the HTTP server.

Currently `nx_http_server_create` is a user written code, but will be generated by the configurator in SSP v1.2.0. In this application, it is still a user written code and is part of `http_server_thread.c`.

Note: Before the USB device is detected/inserted, the HTTP server gets created by the Synergy Configurator with `&g_fx_media0`, that is a pointer to the FileX Media Control Block for a USB flash device. This media pointer should be updated before the HTTP Server gets started.

The HTTP server creation API also requires the `authentication_check` and `get_notify` functions where the user page creation and handling of the page specific `Get`/`Set` are handled. These are in `src/demo_nx_http_httpserver_query.c`. In addition to the page hosting, it also gives the option to Get/Set the user data from/on to the page. The thread also sets the event flag to indicate the LED control thread that the user desired operation (ON/OFF/BLINK) for the LEDs on the board.

Once the USB removed event is gotten from USB Thread, this thread will stop the NetX HTTP server and turn off the LED Control Thread.

5.2 LED Control Thread

This thread mainly controls the LEDs based on the event received from the user through the HTTP server page.

5.3 USB Thread

The entry function of this thread doesn't contain any necessary process for USB Mass Storage operation. The `ux_host_change_callback,` that is used for checking the USB Device insertion and setting the event to inform the HTTP Server Thread, is located on the same source file.

The sample directory structure of the NetX Webserver application code, the DM9051 Add-on module, and its related driver, and code are shown in Figures 14 and 15. The DM9051 Add-on module is an add-on, and its relative files are listed under `synergy/ssp/src/framework/sf_ether_dm9051,` `synergy/ssp/src/framework/sf_ether_dm9051_nsal_nx,` and `synergy/ssp/inc/framework/api` folder.

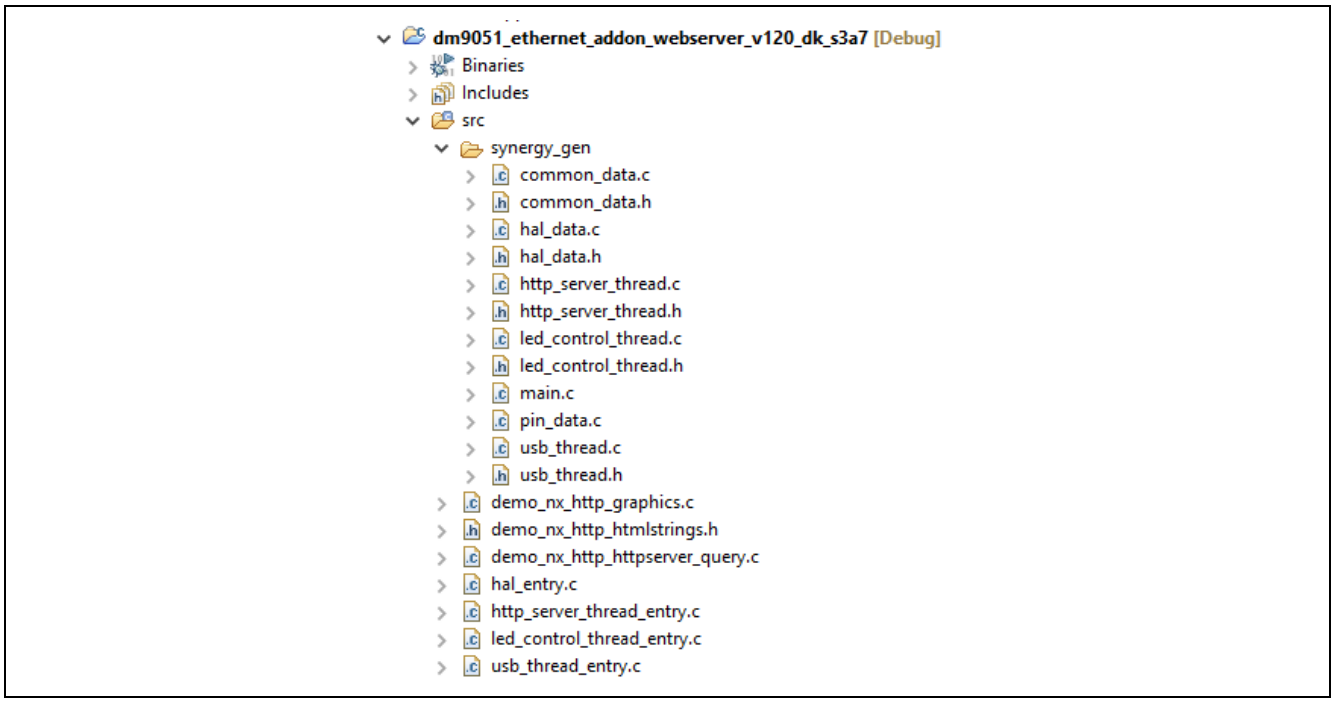


Figure 14 NetX Webserver application and the Synergy Configurator created code

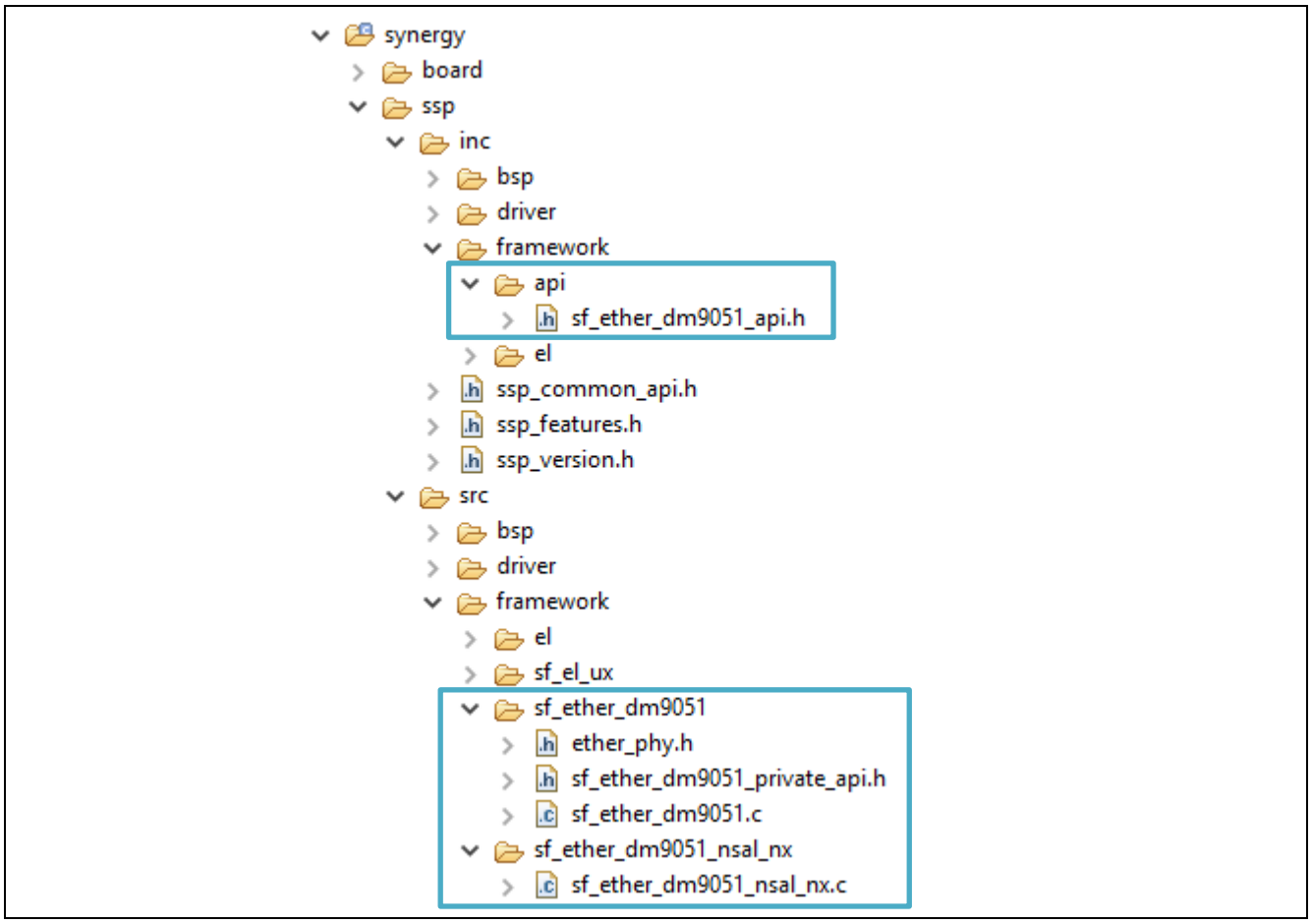


Figure 15 DM9051 add-on code and its driver directory structure

Website and Support

Support: https://synergygallery.renesas.com/support

Technical Contact Details:

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Oct 25, 2017	-	Initial version

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