AN1320: Building a Customized NCP Application with Zigbee EmberZNet 7.x

The ability to build a customized NCP application image was introduced in EmberZNet PRO 5.4.1. Version 7.0 of the Zigbee EmberZNet SDK, used with Simplicity Studio 5, inroduced a component-based project architecture that replaced AppBuilder. This application note provides instructions for configuring various aspects of a component-based NCP application using the tools included in Simplicity Studio 5.

If you are working with Zigbee EmberZNet SDK v 6.10.x or lower, see *AN1010: Building a Customized NCP Application* for this information.

KEY POINTS

- Instructions cover starting from anexample or from a new file.
- Customizations include target hardware, initialization, main loop processing, event definition and handling, and host/NCP command extensions.

1 Introduction

The Zigbee EmberZNet stack supports the ability to build NCP applications in the Simplicity Studio IDE, with customizations for target hardware, initialization, main loop processing, event definition and handling, and host/NCP command extensions. This application note describes how to configure a customized NCP application using the Zigbee EmberZNet 7x stack for EFR32 devices.

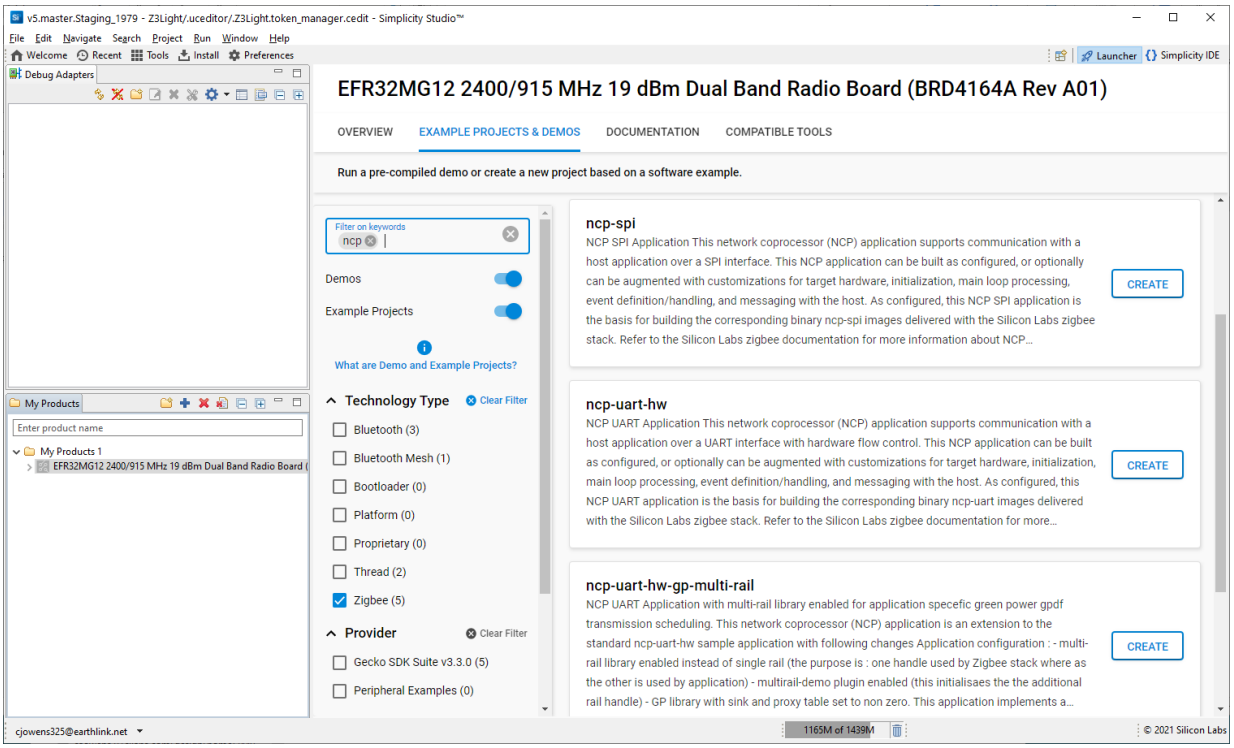
If you are not familiar with using Simplicity Studio to configure an example application and then build the application image and load it and a bootloader onto a device, refer to *QSG180: Zigbee EmberZNet Quick-Start Guide for SDK 7.x and Higher* and the online Simplicity Studio 5 User's Guide.

A PIN tool is available that allows you to modify peripheral configurations, including pin settings. You can access the tool through the Project Configurator Tools tab. See the Simplicity Studio 5 User's Guide for more information.

2 Theory of Operation

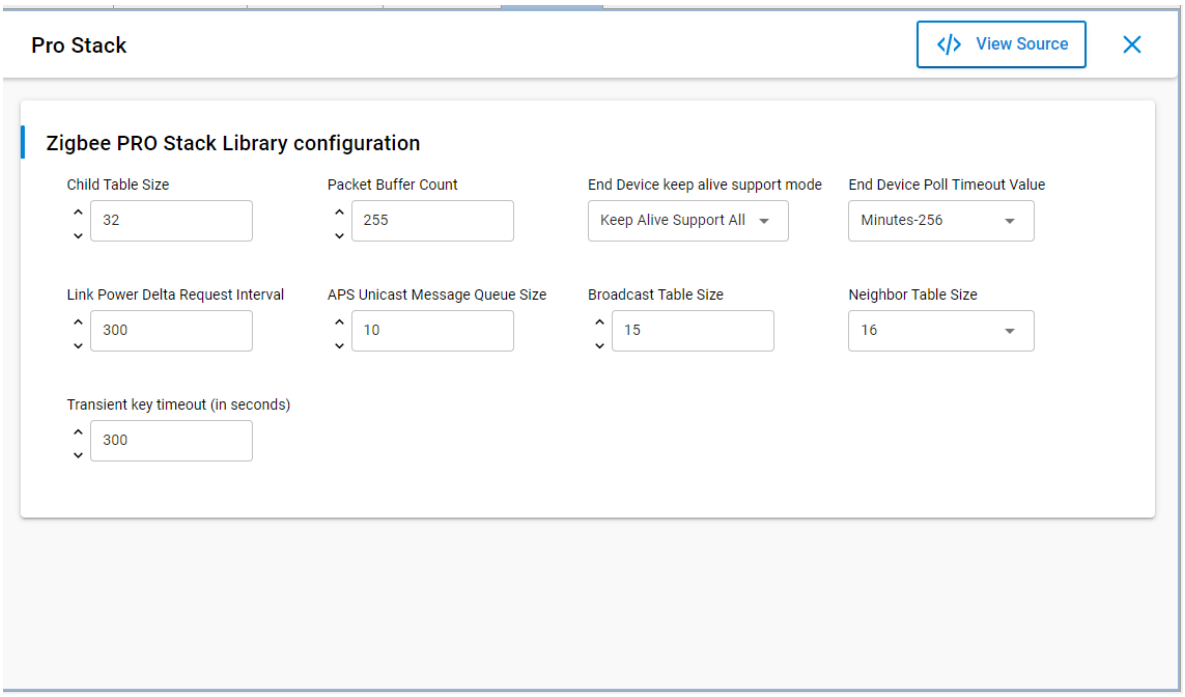
The Zigbee EmberZNet stack includes example applications that can be configured to work over either SPI or UART. Silicon Labs recommends that you use either the NCP SPI or NCP UART (HW) example applications as a starting point for building a customized NCP application. Starting in GSDK version 4.1.0.0 or EmberZNet version 7.1.0.0, Host and NCP applications can be configured to work over a Co-Processor Communication (CPC) link, whereby CPC handles the physical UART or SPI connection. CPC provides reliable and secure transport across either SPI or UART serial lines. In addition, CPC supports multiprotocol operation by allowing multiple endpoints on either side of the serial line. For more information on how CPC works, see AN1351: Using the Co-Processor Communication Daemon (CPCd). For information on using CPC with multiprotocol RCP and NCP applications, see AN1333: Running Zigbee, OpenThread, and Bluetooth Concurrently on a Linux Host with a Multiprotocol Co-Processor.

The following instructions show how to build a standard NCP SPI or NCP UART (HW) application. More information is provided later in this document on how to build an NCP CPC application, or an NCP that is meant to interface with CPC in order to communicate to the host processor.



To override the default stack settings for the NCP, find and select the **Pro Stack** component, and click **Configure**. For example, to change the maximum number of supported end device children from the default of 32, under the **Child Table Size** parameter, enter the desired

maximum number of end device children that you can join directly to the NCP. Note that the maximum value is 64. The precompiled NCP binaries are limited to 32 children.



3 Component Customizations

One way to customize your NCP design is through the component configuration. Examples of common customizations follow. On the Software Components tab, use Search and the filters to find the referenced components.

3.1 Default Pins

For EFR32 platforms, to change the default pins used for EZSP-SPI or EZSP-UART communication, use the following instructions:

- For SPI NCP designs:
  - Install the **SPI NCP Configuration** component. This should already be installed if you are starting from the **NCP SPI** example application. In the component configuration options, check that the **Selected Module** setting matches your desired USART for SPI NCP communication and that the **LEGACY_NCP_SPI_WAKE_INT** and **LEGACY_NCP_SPI_HOST_INT** pin settings match your desired signal pinout for SPI communication.
- For UART NCP designs:
  - Select the **vcom** component and install it if it is not already installed. In the Component Editor, on the **SL_IOSTREAM_USART_VCOM** card, verify that the **Selected Module** setting matches your desired USART Port for UART NCP communication.
- For CPC NCP designs, no action is needed, as configuration is handled by the CPC instance.

3.2 Network and Stack Parameters

- In the **Binding Table Library** component, change the **Binding Table Size** parameter to the max desired binding table size used by the NCP.
- In the **Security Link Keys Library** component, change the **Link Key Table Size** parameter to the desired maximum number of unique APS link keys used by the NCP. Note that if you are configuring your NCP to act as a Trust Center with Zigbee 3.0 Security (as set in the **Network Creator Security** component), it is not necessary to have a unique key table entry for every device. Instead, a single security key known as a Master Key is used to compute unique keys via an AES-HMAC hash function for each device. However, supporting install-code-based keys requires a link key table with as many entries as the number of install-code-based keys you wish to support simultaneously for joining devices with install code support.
- In the **Pro Stack** component, change the **Child Table Size** parameter to the desired maximum number of end device children joined directly to the NCP. Note that, while the on-screen text says the value range is 0-127, you cannot build the app if you enter a value greater than 64. The precompiled images are limited to 32 children.
- In the **Pro Stack** component, increase/decrease other option parameters to meet your needs. You may need to reduce values like **Packet Buffer Count**, which has a high RAM overhead, if your build fails due to lack of available RAM in the memory map. However, note that most memory-related parameters here simply represent defaults when the NCP boots, and these settings can be overridden by the host during run-time configuration when the NCP is initialized.

3.3 Security

For devices implementing Trust Center functionality (either as a coordinator providing centralized trust center responsibilities for the network or a router in a decentralized trust center configuration), you may wish to override the EZSP Trust Center policy's decisions about when and how to provide the current network security key to a joining or rejoining device. The following callback provides this feature:

```
EmberJoinDecision emberAfPluginEzspSecurityTrustCenterJoinCallback(EmberNodeId newNodeId,
                                                                   const EmberEUI64 newNodeEui64,
                                                                   EmberDeviceUpdate status,
                                                                   EmberNodeId parentOfNewNode,
                                                                   EzspDecisionId decisionId,
                                                                   EmberJoinDecision joinDecision)
```

3.4 NCP Event Definition and Handling

Event definitions and handlers must be defined directly in the source code. More details can be found in *UG491: Application Framework Developer's Guide for SDK 7.x*.

3.5 Custom Messaging

To implement custom messages between NCP and host, the developer defines and implements the format, parsing, and serialization of the message set. The serialized messages are conveyed between NCP and host as opaque byte strings. This “extensible network co-processor” functionality is provided by the **XNCP** component.

To send a custom message to the host, construct and serialize the message, then send the resulting byte string to the host using the EmberZNet PRO API function `emberAfPluginXncpSendCustomEzspMessage()`.

After installing the XNCP component, the following callback definitions are provided through the component for custom 2-way messaging over EZSP. They should be implemented in the project callbacks file.

`emberAfPluginXncpIncomingCustomFrameCallback` - Processing of custom incoming serial frames from the EZSP host

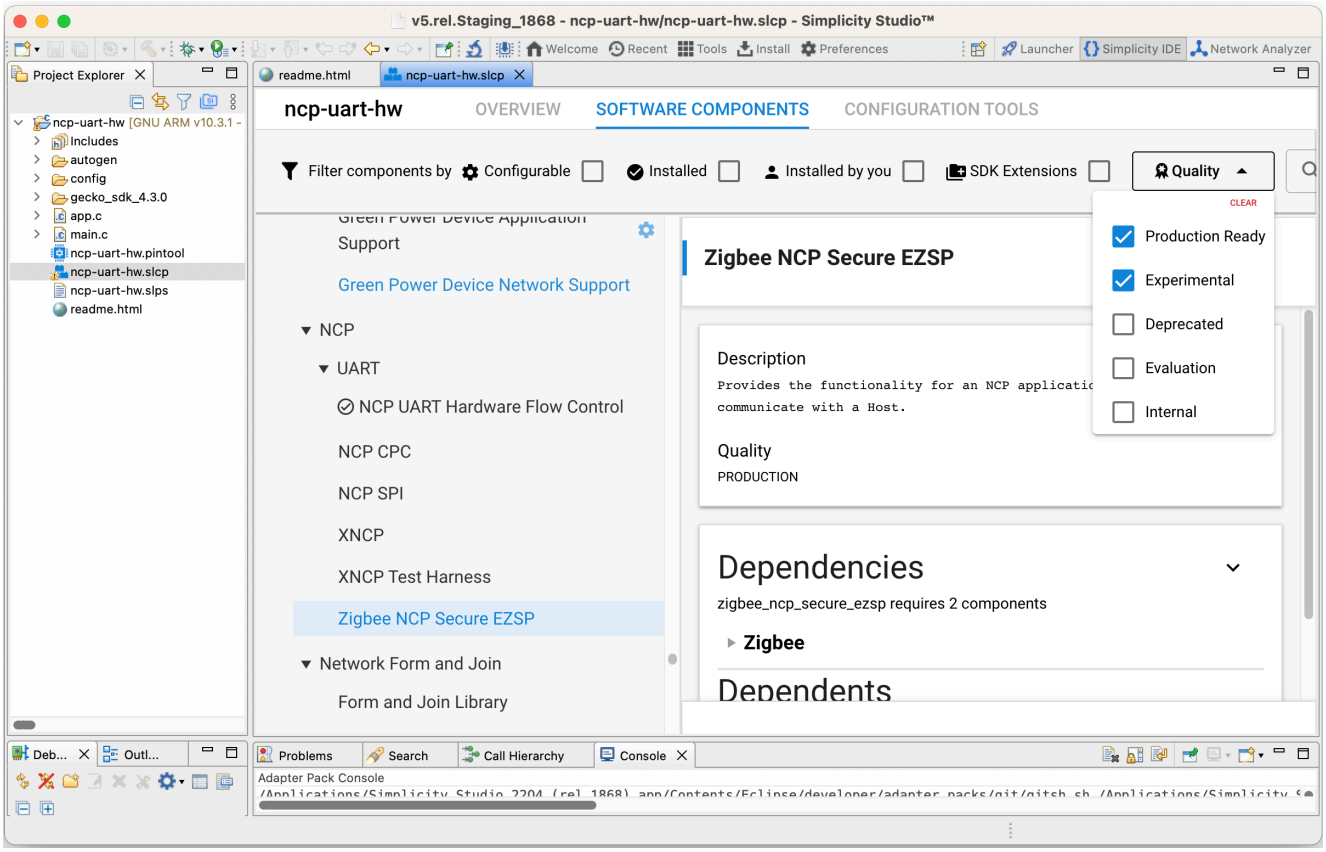
`emberAfIncomingMessageCallback` - Custom processing of received Zigbee application layer messages before passing these (through Incoming Message Callback frames) to the EZSP host

Note that custom outgoing serial frames from the NCP to the EZSP host should be provided as response frames to the host in reply to a Callbacks EZSP command or some custom host-to-NCP EZSP command, where they can be handled by the following host-side callback: `void ezspCustomFrameHandler(int8u payloadLength, int8u* payload)`.

3.6 Serial Transport

In GSDK version 4.1.0.0 or EmberZNet version 7.1.0.0, users have several options for handling the serial transport of commands between the host application and NCP application. The NCP SPI and NCP UART (HW) applications have code that handles the serialization of data across the SPI or UART connection. These applications do not use CPC. In order to have the application utilize CPC to communicate to the host application, the following changes can easily be made to an existing NCP application.

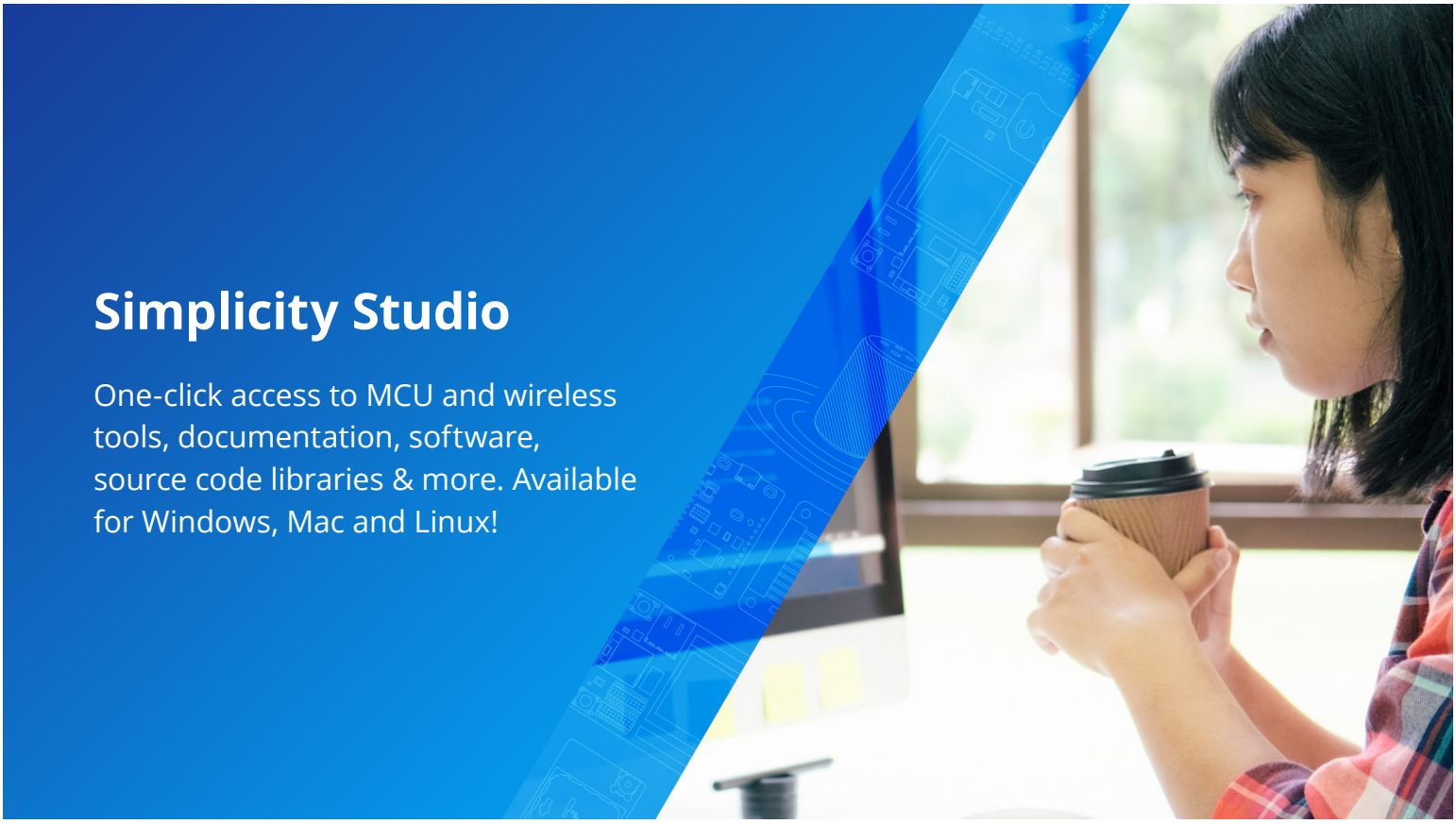
Begin by creating either the NCP SPI or NCP UART (HW) application in Simplicity Studio. The project name may be changed to ncp-cpc if desired. Once the project landing page loads, open the Software Components tab, and click the Quality filter. Make sure that Production and Evaluation components are visible. An example is shown below.



All that remains is to update the following components:

- Unselect NCP UART Hardware Flow Control, if selected. This will also remove dependencies.
- Unselect NCP UART Software Flow Control, if selected. This will also remove dependencies.
- Unselect NCP SPI, if selected. This will also remove dependencies.
- Unselect the IO Stream: USART component and its VCOM instance, if installed.
- Select and install either the CPC Secondary – SPI (USART) or CPC Secondary – UART (USART) component based on the configured serial line. A popup will appear prompting for an instance name. After choosing an instance name, click **Done**.
- Select and install NCP CPC.

Once this is complete, the project is configured. The project can now be built and flashed to an EFR32, which will allow the device to connect with a CPC-capable host application.



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