Application Note: JN-AN-1117

Network Discovery Tool

This Application Note demonstrates how to use a Jennic JN5139/JN5148 evaluation kit to implement a network discovery tool which detects wireless networks and devices within radio range of the tool. The application uses the IEEE 802.15.4 beacons to display the network information.

Features of this Application Note include:

- **Supports JenNet, ZigBee, ZigBee PRO and IEEE 802.15.4 networks**
- **Site Survey option**
- **Scrollable display (LCD) on the network discovery tool**
- **Selectable radio channel and network protocol**
- **Information detail filtering**

Application Overview

This application uses the controller board (with LCD screen) from a Jennic JN5139 or JN5148 evaluation kit as a network discovery tool which detects and displays all the wireless network devices within radio range of the board.

- The user has the option to select the Site Survey tool which will display the activity on all channels in the 2.4-GHz band.
- The user can select the type of network to detect – a network based purely on the IEEE 802.15.4 protocol, based on Jennic's proprietry JenNet protocol or based on the ZigBee standard (ZigBee or ZigBee PRO). This choice determines how the obtained information is displayed.
- The user must also select a 2.4-GHz band channel to scan.

After the above selections have been made, the software performs 10 active scans of the specified channel for networks of the specified type, and displays the results. All duplicated results are filtered so that only one result per MAC address is displayed. The user can scroll the list of results and, if required, choose one of the devices found and display all the information available within the beacon payload from the device.

Software Overview

The network discovery tool is supplied as two pre-built binary files, **NetworkDiscoveryTool_JN5139.bin** and **NetworkDiscoveryTool_JN5148.bin**. The appropriate binary file must be programmed into the Flash memory of the controller board - this can be done using the Flash Programmer application provided in the Jennic SDK toolchain (JN-SW-4031 or JN-SW-4041).

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Using the Network Discovery Tool

To use the network discovery tool proceed as follows:

1. Switch on the controller board using the slide-switch on the side of the board.

   The LCD screen then shows the Jennic logo and offers the user the option of selecting a site survey.

2. Select whether a site survey is required – switch SW1 enables a site survey and switch SW3 disables a site survey. If this feature is enabled, the display shows the activity on all channels - see Figure 1 below.

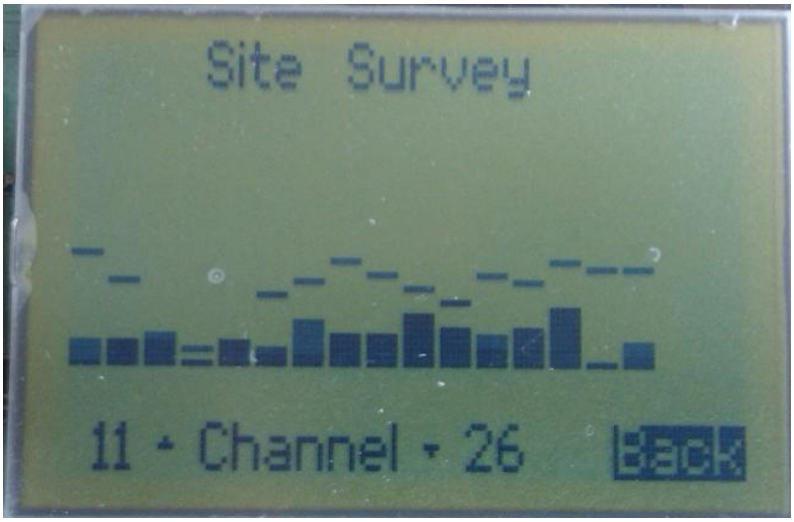

Figure 1: Site Survey Results

   The vertical bars represent the current radio activity on each channel, with the horizontal line above representing the highest activity recorded for that channel since the site survey started. Each time the display is refreshed (about once a second), if the current activity is less than the highest recorded activity the horizontal line position is reduced by 1. The scan that is used to discover the activity is an energy scan, so the closer the device is to the network discovery tool the greater the vertical bar.

3. Select the type of network to discover – switch SW1 selects a pure IEEE 802.15.4 network, SW2 select ZigBee networks, switch SW3 selects a JenNet network and SW4 selects ZigBee PRO networks.

4. Select the 2.4-GHz channel to be scanned – pressing switch SW2 increments the channel and pressing switch SW3 decrements the channel. To scan all channels, press SW2 until **All** is displayed as the channel. The default channel is 11.

5. Once the desired channel is displayed, press switch SW4 to start the network discovery.

   The software now scans the selected channel(s) 10 times. When all 10 scans are complete on each channel selected, the LCD screen shows a list of all the devices found. The network discovery tool uses beacon responses to generate the displayed data. If a device's beacon payload length is set to zero, the network discovery tool does not display the device.

Flowchart

Figure 2 shows the operation of the tool in flowchart form.

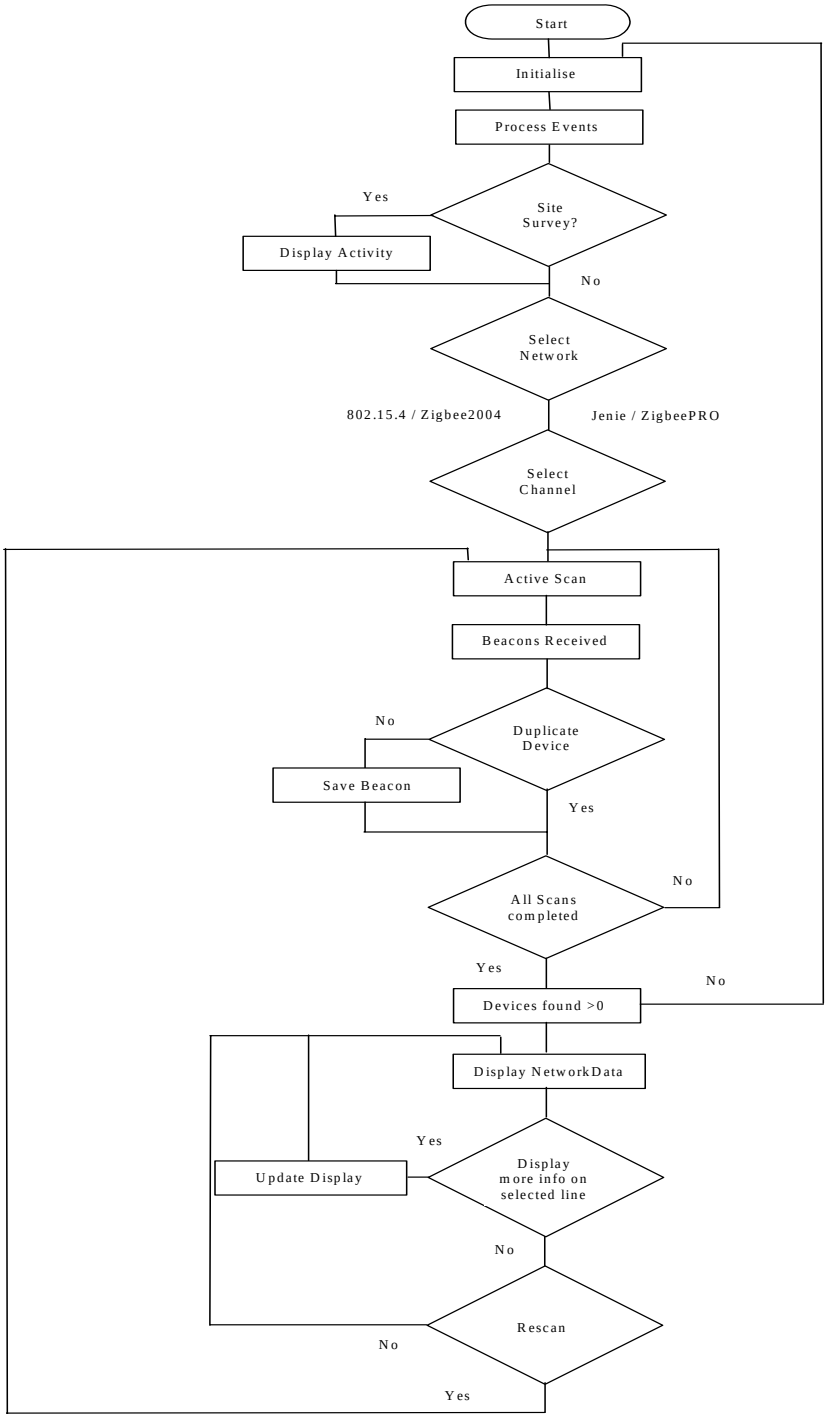

Figure 2: Operational flow of the Network Discovery tool

IEEE 802.15.4 Scan Results

If you selected IEEE 802.15.4 networks to be discovered, the results are displayed as follows:

Addr The address of the detected device - either a short address or the 16 least significant bits of the MAC address.

LQI The LQI value, which is a decimal value between 0 and 255 that indicates the radio signal strength, 255 being the maximum signal strength.

PayLen The length of the beacon payload received, in bytes.

AM The address mode of the device - if “E” is displayed then the address mode is extended addressing and if “S” is displayed then the address mode is short addressing.

Ch The channel on which the device was detected.

A maximum of 5 devices are shown on the LCD screen at any one time, but you can use switch SW4 to scroll down and switch SW3 to scroll up the list of devices. As you scroll up and down, the highlighted line changes until the 5th line on the LCD screen is highlighted. If there are more devices within the list, the 5th line remains highlighted but the device list scrolls upwards. If there are more than 5 nodes in the list, the total number of nodes found will be displayed when you scroll to the end of the list. Figure 3 below shows an example of the screen display.

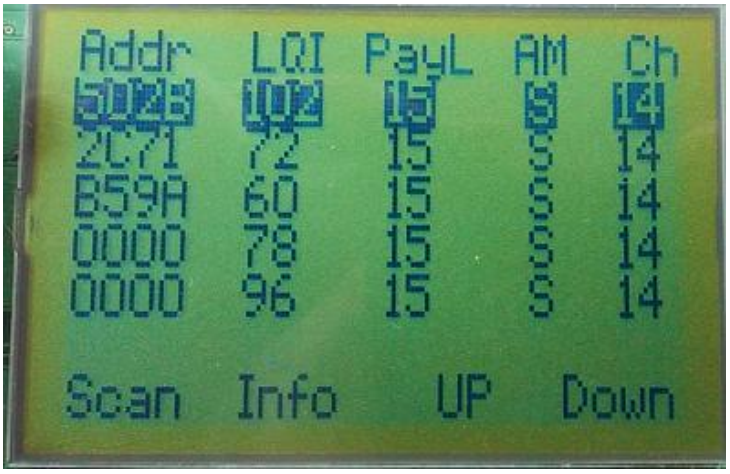

Figure 3: Typical IEEE 802.15.4 Discovery Results

When you press switch SW2 (Info), all of the available information within the payload of the highlighted device is presented. The beacon payload of the selected device is displayed from left to right across the LCD screen in successive characters, as shown in Figure 4 below.

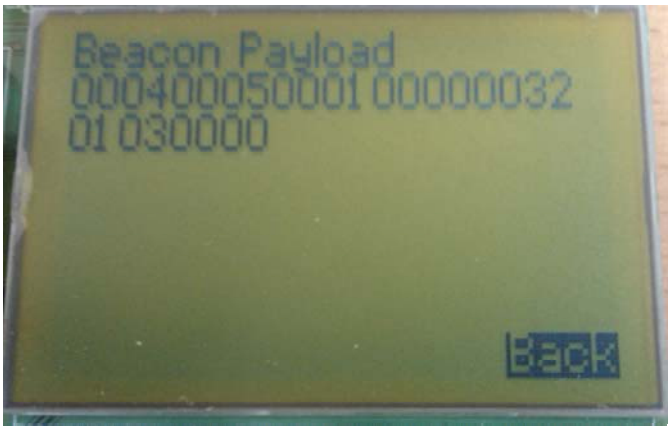

Figure 4: Displaying Beacon Payload

You can then press switch SW4 to return to the list of devices.

ZigBee Scan Results

If you selected ZigBee networks to be discovered, the results are displayed as follows:

Addr The short address of the detected device.

PAN The 16-bit PAN ID of the detected device.

LQI The LQI value, which is a decimal value between 0 and 255 that indicates the radio signal strength, 255 being the maximum signal strength.

PayL The length of the beacon payload received, in bytes.

Ch The channel on which the device was detected.

A maximum of 5 devices are shown on the LCD screen at any one time, but you can use switch SW4 to scroll down and switch SW3 to scroll up the list of devices. As you scroll up and down, the highlighted line changes until the 5th line on the LCD screen is highlighted. If there are more devices within the list, the 5th line remains highlighted but the device list scrolls upwards. If there are more than 5 nodes in the list, the total number of nodes found will be displayed when you scroll to the end of the list. Figure 6 below shows an example of the screen display.

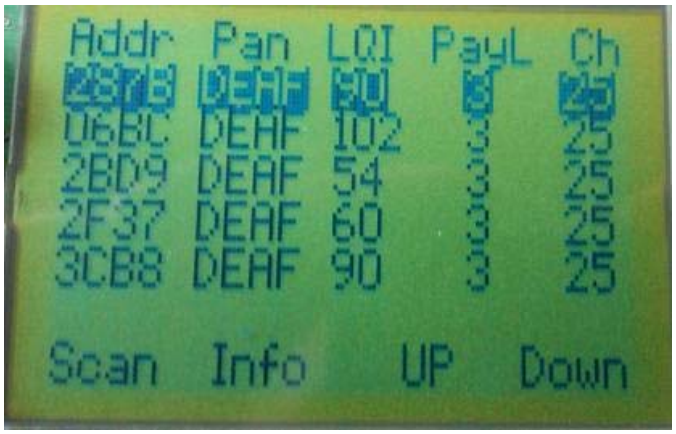

Figure 5: Typical ZigBee Discovery Results

If you press switch SW2 (Info), all of the available information within the payload of the highlighted device will be displayed as follows:

End Capacity This value will be TRUE if the device selected is capable of accepting join requests from end devices and is set to FALSE otherwise.

Router Capacity This value will be TRUE if the device selected is capable of accepting join requests from router-capable devices and is set to FALSE otherwise.

Depth The network depth of the device selected. A value of 0 indicates that this device is the ZigBee coordinator for the network.

MAC The MAC address will only be displayed if the device selected has a route, within the device routing table, back to the coordinator.

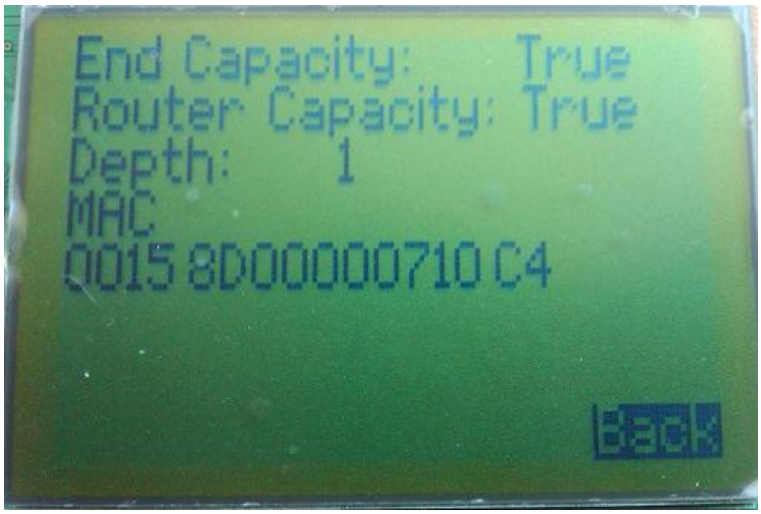

Figure 6: Displaying ZigBee Beacon Payload

You can then press switch SW4 to return to the list of devices.

JenNet Scan Results

If you selected JenNet networks to be discovered, the results are displayed as follows:

MAC The 16 least significant bits of the detected device's MAC address.

Net ID The 32-bit Network Application ID of the detected JenNet network.

AS '1' if 'permit joining' is enabled or '0' if 'permit joining' is disabled on the device.

CH Number of children that the device has.

Ch The channel on which the device was detected.

A maximum of 5 devices are shown on the LCD screen at any one time, but you can use switch SW4 to scroll down and switch SW3 to scroll up the list of devices. As you scroll up and down, the highlighted line changes until the 5th line on the LCD screen is highlighted. If there are more devices within the list, the 5th line remains highlighted but the device list scrolls upwards. If there are more than 5 nodes in the list, the total number of nodes found will be displayed when you scroll to the end of the list. Figure 7 below shows what the screen looks like when you are at the end of the list.

Figure 7: Typical JenNet Discovery Results

If you press switch SW2 (Info), all of the available information within the payload of the highlighted device will be displayed as follows:

Version The first 4 digits displayed correspond to the software version number and second 4 digits correspond to the protocol version number.

Depth The depth of the device in the network tree (the Co-ordinator is at zero depth).

Net ID The 32-bit Network Application ID of the detected JenNet network.

Associate '1' if 'permit joining' is enabled or '0' if 'permit joining' is disabled on the device.

Children Number of children that the device has.

User Def A 16-bit value set by the network user.

MAC The 16 least significant bits of the MAC address of the selected device.

LQI The LQI value, which is a decimal value between 0 and 255 that indicates the radio signal strength, 255 being the maximum signal strength.

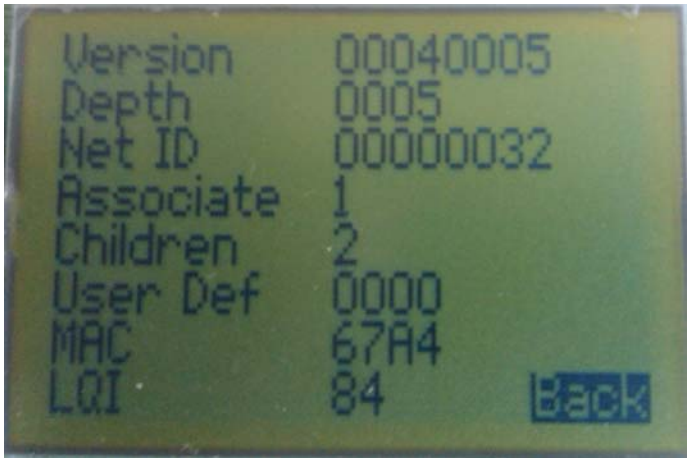

Figure 8: JenNet Beacon Payload

You can then press switch SW4 to return to the list of devices.

ZigBee PRO Scan Results

If you selected ZigBee PRO networks to be discovered, the results are displayed as follows:

Addr The short address of the detected device.

PAN The 16-bit PAN ID of the detected device.

LQI The LQI value, which is a decimal value between 0 and 255 that indicates the radio signal strength, 255 being the maximum signal strength.

PayLen The length of the beacon payload received, in bytes.

Ch The channel on which the device was detected.

A maximum of 5 devices are shown on the LCD screen at any one time, but you can use switch SW4 to scroll down and switch SW3 to scroll up the list of devices. As you scroll up and down, the highlighted line changes until the 5th line on the LCD screen is highlighted. If there are more devices within the list, the 5th line remains highlighted but the device list scrolls upwards. If there are more than 5 nodes in the list, the total number of nodes found will be displayed when you scroll to the end of the list. Figure 9 below shows an example of the screen display.

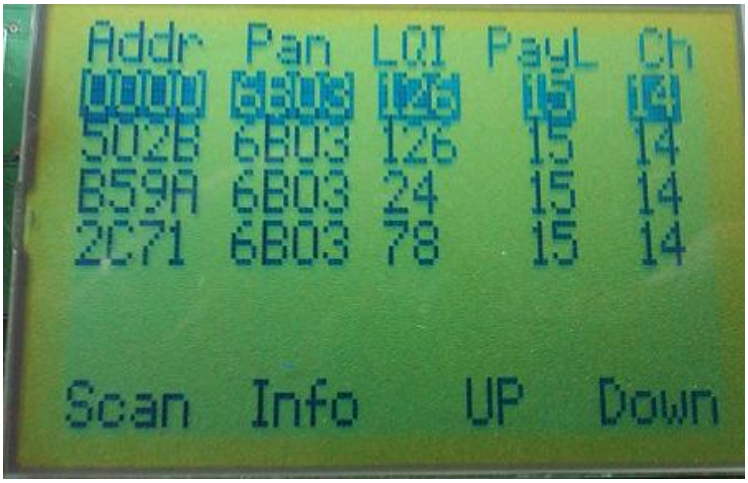

Figure 9: Typical ZigBee PRO Discovery Results

If you press switch SW2 (Info), all of the available information within the payload of the highlighted device will be displayed as follows:

Stack Profile A ZigBee stack profile identifier.

NwK Protocol Ver The version of the ZigBee protocol.

Router Capacity This value will be TRUE if the device selected is capable of accepting join requests from router-capable devices and is set to FALSE otherwise.

Device Depth The network depth of the device selected. A value of 0 indicates that this device is the ZigBee Co-ordinator for the network.

End Capacity This value will be TRUE if the device selected is capable of accepting join requests from End Devices and is set to FALSE otherwise.

Extended PanID The globally unique ID for the PAN of which the beaconing device is a member. By default, this is the 64-bit address of the ZigBee Co-ordinator that formed the network, but other values are possible and there is required structure to the address.

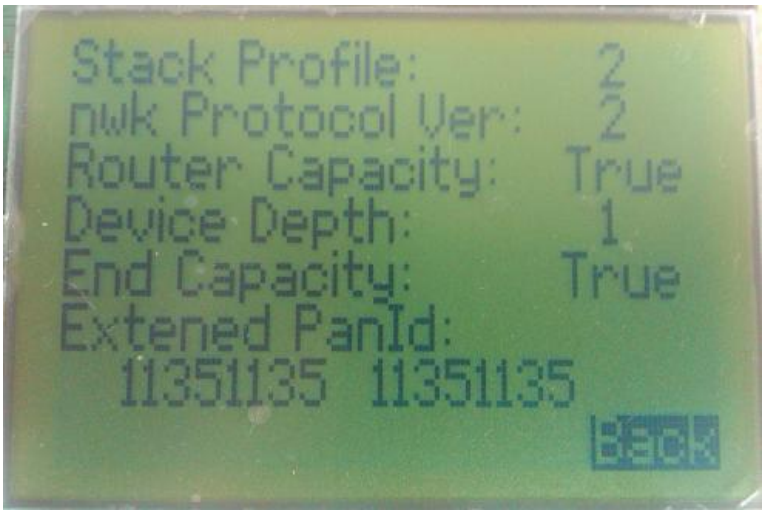

Figure 10: Displaying ZigBee PRO Beacon Payload

You can then press switch SW4 to return to the list of devices.

Practical Use of the Network Discovery Tool

The Site Survey tool is useful when carrying out a site survey. It gives the user a graphical representation of the radio activity on each channel, so the user can decide not to use a particular channel if it is very busy.

The network discovery tool is useful when installing and commissioning networks.

Consider the example of finding the optimum position of a Router between two fixed nodes, which are the Co-ordinator (e.g. the control unit) and an End Device (e.g. a window monitor) in an alarm system. The End Device has a fixed location as a window monitor and the Co-ordinator has a fixed location in order to gain access to a power supply and/or telephone line needed for the control unit.

To find the ideal position for a Router between these two nodes:

1. Switch on the Co-ordinator and then use the network discovery tool to perform a scan on the relevant channel to find all devices within range - the device(s) shown will include the Co-ordinator.
2. Now use the network discovery tool to perform another scan at the position of the End Device to determine whether the Co-ordinator is within range of the End Device. If the Co-ordinator is detected and the LQI value is adequate then there is no need for a Router between the two nodes.
3. If the network discovery tool cannot detect the Co-ordinator with a sufficient LQI value while in the position of the End Device, move the tool in the direction of the Co-ordinator and attempt to locate the ideal position for the Router - the ideal location is the point where the LQI values for the Co-ordinator and End Device are roughly equal. Also take into consideration any other devices within proximity of the Router, as it may be possible to use a single Router for several nodes (window monitors).

The network discovery tool displays the LQI values for all devices that it detects. When commissioning (e.g. an alarm system), the user can walk around the building with the tool and check that all LQI values are adequate to relay data to the Co-ordinator directly or via a Router, even with doors closed, objects in the way, and so on.

Compatibility

The software provided with this Application Note has been tested with the following Jennic kits and SDK versions:

Product Types	Part Numbers	Version	Supported Networking Protocols
Evaluation Kit	JN5139-EK000	-	JenNet, IEEE 802.15.4, ZigBee
	JN5139-EK010	-	JenNet, IEEE 802.15.4, ZigBee
	JN5148-EK010		ZigBee PRO
SDK Libraries	JN-SW-4030	1.4	-
SDK Toolchain	JN-SW-4031	1.1	-
SDK Libraries	JN-SW-4040	1.0.0	-
SDK Toolchain	JN-SW-4041	1.0.0	-

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Building and Downloading the Application

In order to build the software provided with this Application Note, the application's folder must be placed in the correct directory dependant on which SDK is installed. The default root directory is **C:\Jennic\cygwin\jennic\SDK\Application** for JN-SW-4030 SDK libraries and JN-SW-4031 SDK toolchain and is **C:\Jennic\Application** for JN-SW-4040 SDK libraries and JN-SW-4041 SDK toolchain. This directory is automatically created when you install the latest Jennic Software Developer's Kit (SDK), if installed in the default location. You can obtain the latest versions of the SDK libraries and SDK toolchain from the Support area of the Jennic web site (www.jennic.com/support).

> **Note:** This application uses IEEE 802.15.4, which is supported on the JN513x chip family and JN5148. Makefiles and Code::Blocks project files for the JN513x chips are provided. Makefiles and Eclipse project files for the JN5148 are provided. Your chip type is marked on the chip or module.

You can build the application as described in the appropriate section below, depending on whether you wish to use the Code::Blocks IDE, Eclipse IDE or makefiles.

Using Code::Blocks

To build and download the application, follow the instructions below:

1. Ensure that the project directory is located in

   <JENNIC_SDK_ROOT>\cygwin\jennic\SDK\Application

   where **<JENNIC_SDK_ROOT>** is the path into which the Jennic SDK was installed (by default, this is **C:\Jennic**).

2. Open the appropriate Code::Blocks project files (**.cbp** files in the **CodeBlocksProject** directory) and build.

   The binary file will be created in the **5139_Build** directory, the resulting filename matching that of the project file used to create it.

3. Download the resulting binary file from the appropriate **Build** directory to the board. You can do this using the Jennic JN51xx Flash Programmer application or directly from Code::Blocks (if you have installed the integrated Flash programmer).

Using Makefiles

To build and download the application, follow the instructions below:

1. Ensure that the project directory is located in

   <JENNIC_SDK_ROOT>\cygwin\jennic\SDK\Application

   where **<JENNIC_SDK_ROOT>** is the path into which the Jennic SDK was installed (by default, this is **C:\Jennic**).

2. In the **Build** directory, open the supplied makefile (with a text editor) and check the variables at the beginning of the file to ensure that the appropriate chip type and networking stack are selected.

3. Still in the **Build** directory, enter `make` at the command prompt to build the application.

   The binary file will be created in the **Build** directory, the resulting filename indicating the application for which the binary was built.

4. Download the resulting binary file from the **Build** directory to the board using the Jennic JN51xx Flash Programmer application.

> **!** ***Caution:*** *If problems occur when using your current Code::Blocks version, download the latest version along with the latest version of this Application Note from the Support area of the Jennic web site (www.jennic.com/support).*

Using Eclipse

To build the application and load it onto the JN5148 boards, follow the instructions below:

1. Ensure that the project directory is located in

<JENNIC_SDK_ROOT>\Application

where **<JENNIC_SDK_ROOT>** is the path into which the SDK was installed.

2. Start the Eclipse platform and import the relevant project files (**.project** and **.cproject**) as follows:

a) In Eclipse, follow the menu path **File>Import** to display the **Import** dialogue box.

b) In the dialogue box, expand **General**, select **Existing Projects into Workspace** and click **Next**.

c) Enable **Select root directory**, browse to the Jennic **Application** directory and click **OK**.

d) In the **Projects** box, select the project to be imported and click **Finish**.

3. Build the project. To do this, ensure that the project is highlighted in the left panel of Eclipse and use the drop-down list associated with the hammer icon in the Eclipse toolbar to select the relevant build configuration – once selected, the project will automatically build.

The binary files will be created in the relevant build configuration directory.

4. Load the resulting binary files (Release or Software Debug) into the boards from the appropriate build configuration directory. You can do this directly from Eclipse or using the Jennic JN51xx Flash Programmer (described in the *JN51xx Flash Programmer User Guide (JN-UG-3007)*).

Revision History

Version	Notes
1.0	First release
1.1	Site Survey tool added
1.2	ZigBee and ZigBee PRO discovery added
1.3	Multiple-channel scan added

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