Jennic
TECHNOLOGY FOR A CHANGING WORLD

Application Note: JN-AN-1002

Light Switch Application

This Application Note describes how to create a simple light switch application which demonstrates the following aspects of IEEE 802.15.4 based wireless networks:

- **Creating a star network without regular beacons**
- **Performing asynchronous data transfers from device to PAN Coordinator**
- **Using sleep mode and wake-up events to achieve low power consumption**

Introduction

This Application Note describes how to create a basic wireless light switch system using two sensor boards and a controller board from a JN5148, JN5139 or JN5121 evaluation kit. The software required to implement the system is based on the IEEE 802.15.4 protocol stack and the Jennic Integrated Peripherals (Hardware) API, both provided free-of-charge by Jennic.

Application Overview

Two sensor boards and a controller board from the evaluation kit simulate the wireless light switch system.

- On the controller board, LEDs D1-D4 represent the light bulb.
- On the sensor boards, switch SW2 acts as the light switch.

Software on each board implements a complete light switch system where pressing SW2 on either sensor board causes the 'light bulb' on the controller board to toggle.

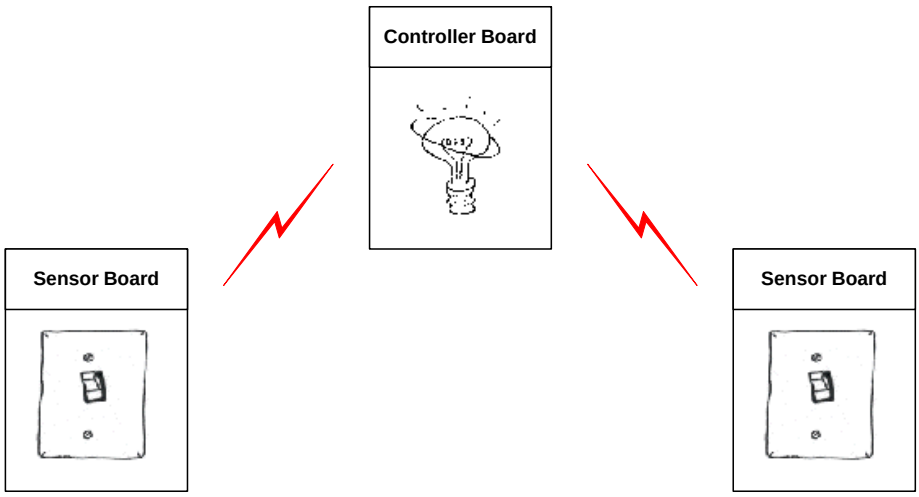

Figure 1: Wireless Light Switch System

Network Architecture

The light switch system is based on a star network in which the controller board acts as the PAN Coordinator and the sensor boards as network devices. In such a system, there is no requirement to periodically transmit data and therefore the network does not use regular beacons. This allows the sensor boards to spend most of the time in low-power sleep mode. Since the controller board is simulating the light bulb, the board is assumed to be permanently powered, constantly listening for sensor board data. When the sensor board switch is pressed, it wakes from sleep mode and transmits a data packet to the controller board before going back to sleep. On receiving such a data packet, the controller board toggles the state of the light.

Controller Board Operation

The software on the controller board performs the following actions:

- Configures the JN51xx device as the PAN Coordinator in a non-beacon enabled star network. The PAN ID and short address for the Coordinator must then be selected, and finally the network can be started.
- Once the network has been started, the Coordinator waits for devices to associate. Each device joining the network is assigned a short address that will be used in all future communications.
- Once at least one device has joined the network, the Coordinator can perform the function of a light bulb. It simply waits for data packets to arrive from devices and, upon reception, toggles the state of the light.

Sensor Board Operation

The software on a sensor board performs the following actions:

- The device performs an active scan of all channels in an attempt to find the Coordinator. An active scan transmits beacon requests on all channels. If the Coordinator is functioning correctly, it generates a beacon when it receives the incoming request on the channel in which it is operating.
- Upon reception of such a beacon, the device associates with the Coordinator and joins the network it has discovered.
- The device can now emulate a light switch. It will sleep until an interrupt is generated by a change-of-state of the switch SW2. At this point, it will send a data packet to the Coordinator before returning to sleep mode.

Software

The software for both the controller and sensor boards is supplied with this document in the ZIP file that can be downloaded from the Support area of the Jennic web site. This ZIP file also contains the makefile (for command line users) and Code::Blocks project files (for IDE users) required to build the application – see the next section.

Compatibility

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

Product Type	Part Number	Version	Supported Chips	Supported Protocols
Evaluation Kit	JN5121-EK000	-	JN5121	802.15.4
	JN5121-EK010	-	JN5121	802.15.4, ZigBee
	JN5139-EK000	-	JN5139	802.15.4, JenNet
	JN5139-EK010	-	JN5139	802.15.4, JenNet, ZigBee
	JN5148-EK010	-	JN5148	802.15.4, ZigBee PRO
SDK Libraries	JN-SW-4030	v1.5	JN5139, JN5121	802.15.4, JenNet, ZigBee
	JN-SW-4040	v1.1	JN5148	802.15.4, ZigBee PRO
SDK Toolchain	JN-SW-4031	v1.1	JN5139, JN5121	-
	JN-SW-4041	v1.0	JN5148	-

Building and Loading the Application

The software provided with this Application Note can be built for any Jennic wireless controller: JN5148, JN5139 or JN5121. However, the available build methods differ between these chip types:

- JN5148 applications can be built using the Eclipse IDE or makefiles
- JN5139/JN5121 applications can be built using the Code::Blocks IDE or makefiles

Note that different makefiles are provided for JN5148 and JN5139/JN5121.

In order to build the supplied software, the application's folder must be placed in the **Application** folder of the Jennic SDK installation:

- For JN5148: **<JENNIC_SDK_ROOT>\Application**
- For JN5139/JN5121: **<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**). The **Application** directory is automatically created when you install the Jennic SDK.

Build the application as described in the appropriate section below, depending on whether you intend to use Eclipse, Code::Blocks or makefiles.

Using Eclipse (JN5148 Only)

To build the application and load it into 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 an application. 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 application will automatically build. Repeat this to build the other application.

   The binary files will be created in the relevant **Build** directories, the resulting filenames indicating both the chip type (**JN5148**) and networking stack (**154** for 802.15.4) for which they were built.

4. Load the resulting binary files (Release or Software Debug) into the boards. You can do this using the Jennic JN51xx Flash Programmer, which can be launched from within Eclipse or directly (and is described in the *JN51xx Flash Programmer User Guide (JN-UG-3007)*).

Using Code::Blocks (JN5139/JN5121 Only)

To build each application and load it into a JN5139/JN5121 board, 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.

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

   The project files are named according to both the chip type (**JN5139** or **JN5121**) and networking stack (**154** for 802.15.4) for which the binaries are to be built.

   The binary file will be created in the **5139_Build** or **5121_Build** directory.

3. Load the resulting binary file into the board. You can do this using the Jennic JN51xx Flash Programmer, which can be launched from within Code::Blocks or used directly (and is described in the *JN51xx Flash Programmer User Guide (JN-UG-3007)*).

> **!** ***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 Makefiles

Each application has its own **Build** directory, which contains the makefiles for the application.

Different makefiles are provided for JN5148 and JN5139/JN5121 – a JN5148 makefile is simply called **Makefile** while a JN5139/JN5121 makefile is called **Makefile_JN5139.mk**.

To build each application and load it into a JN51xx board, follow the instructions below:

1. Ensure that the project directory is located in

   <JENNIC_SDK_ROOT>\Application for JN5148

   <JENNIC_SDK_ROOT>\cygwin\jennic\SDK\Application for JN5139/JN5121

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

2. Navigate to the **Build** directory for the application to be built and follow the instructions below for your chip type:

   For JN5148:

   At the command prompt, enter:

   ```
   make clean all
   ```

   Note that for the JN5148, you can alternatively enter the above command from the top level of the project directory, which will build the binaries for both applications.

   For JN5139:

   At the command prompt, enter:

   ```
   make -f Makefile_JN5139.mk clean all
   ```

   For JN5121:

   At the command prompt, enter:

   ```
   make -f Makefile_JN5139.mk JENNIC_CHIP=JN5121 clean all
   ```

   In all the above cases, the binary file will be created in the relevant **Build** directory, the resulting filename indicating both the chip type (**JN5148**, **JN5139** or **JN5121**) and networking stack (**154** for 802.15.4) for which the application was built.

3. Load the resulting binary file into the board. To do this, use the Jennic JN51xx Flash Programmer, described in the *JN51xx Flash Programmer User Guide (JN-UG-3007)*.

Revision History

Version	Notes
1.0	Customer release
1.1	Document style updated and source updated for JN5121 v3
1.2	Source added for both ROM-based and Library-based stacks
1.3	Re-templated
1.4	Minor update to lightbulb.c source code and re-templated
1.5	Section added on building and downloading application
1.6	Ported to JN513x devices and new SDK
1.7	Updated for JN5139 and new SDK
2.0	Support for JN5148 added

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