MiWi™ v6.0 Quick Start Guide

Introduction

This document is intended as a starting point for software engineers prototyping, implementing, testing, and deploying wireless sensor networks using MiWi™ Protocol based on the Microchip software platform.

This document describes how to start quickly with the MiWi™ by installing development environment, setup hardware and program devices with reference applications.

Chapter 1 provides an overview of the MiWi™ v6.0 package, lists supported platforms.

Chapter 2 describes the documentation set available for MiWi™ v6.0.

Chapter 3 and Chapter 4 gives instructions on Development tools setup and Hardware environment setup.

Chapter 5 and 6 describes the MiWi™ P2P Protocol applications – Simple_Example_P2P, Chat Demo.

Chapter 7 describes the MiWi™ Star Protocol application – Simple_Example_Star.

Chapter 8 describes the MiWi™ Mesh Protocol application - WSNDemo

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1. Overview

MiWi™ Development Environment (MiWi™ DE) is developed by Microchip to support a wide range of wireless applications. The backbone of MiWi™ DE is MiMAC and MiApp interfaces, which link the support of multiple RF transceivers as well as wireless communication protocols together as a well-defined simple but robust Microchip proprietary wireless development environment.
Within MiWi™ DE, application developers are able to switch between RF transceivers and wireless protocols with little or no modification in the application layer. By providing such easy migration capability in MiWi™ DE, as well as simple but robust interfaces, the firmware development risk has been reduced to a level that has never been observed in the industry before. MiWi™ DE is defined in three layers: application layer, protocol layer and RF transceiver layer. The three layers are linked together by MiMAC and MiApp interfaces. Application layer uses MiApp interfaces to talk to the protocol layer. In protocol layer, there are implementations of MiWi™ P2P, MiWi™Star and MiWi™ Mesh wireless communication protocols available. The drivers for Microchip RF transceivers (AT86RF233, AT86RF212B for this release) are called by protocol layers via MiMAC interfaces. Configuration files are also presented in each layer.

The MiWi™ stack offers a significantly smaller foot-print relative to the open standard based ZigBee® compliant protocol stack. This enables operation in microcontrollers with smaller memory / lower cost.

- MiWi™ P2P/Star – Simple Peer-to-Peer or Star network requiring minimal code size.
- MiWi™ Mesh – A True Routing Mesh network topology. This is perfect for a department store HVAC or alarm application or a large smart home application.

1.1 MiWi™ v6.0 Release Contents

MiWi™ is released as part of ASF. The main items provided as part of MiWi™ Release are:

- Implementation of MiWi™ P2P and Star protocol in form of sources and API header files. The same source is used for all MiWi™ P2P and Star applications.

- Implementation of MiWi™ Mesh protocol in form of libraries and API header files. The same library is used for all MiWi™ Mesh applications.

Source code and IDE projects for reference applications:

- Simple Example P2P – MiWi™ P2P reference application
- Simple Example Star – MiWi™ Star reference application
- WSN Demo – MiWi™ Mesh reference application

Documentation files

- Quick Start Guide
- Migration Guide
- Release Notes

1.2 Supported hardware platforms and IDEs

Microcontroller	RF Transceiver	Supported Evaluation Kit	Supported IDEs
SAMR21G18A(SIP)	RF233(in SIP)	SAMR21 ZLLEK SAMR21 XPRO	Atmel Studio v7.0 IAR Embedded Workbench® for ARM 7.4
SAMR30G18A(SIP)	RF212B(in SIP)	SAMR30 XPRO	Atmel Studio v7.0 IAR Embedded Workbench for ARM 7.4

2. MiWi™ documentation

This Chapter describes the documentation set available for MiWi™. It is intended to help user understand where to find information required during application evaluation and development.

ASK Documentation:

- ASF Documentation http://www.microchip.com/webdoc/asf/index.html
- ASF Getting Started http://www.microchip.com/webdoc/asf/asf.GettingStarted.html
- ASF Wizard http://www.microchip.com/webdoc/asf/asf.ModuleExplorerView.html

MiWi™ Documentation/Tools in web:

- MiWi™ P2P and Star Protocol Application Note http://www.microchip.com/wwwAppNotes/AppNotes.aspx?appnote=en536181
- AN1284 - Microchip Wireless (MiWi™) Application Programming Interface - MiApp
- AN1283 - Microchip Wireless (MiWi™)Media Access Control Interface - MiMAC
- MiWi™ Protocol Sniffer http://www.microchip.com/SWLibraryWeb/product.aspx?product=Wireless%20Development%20Studio

MiWi™ Documentation in ASF package:

Title	Description
Quick Start Guide	This document. User guide to quickly start with MiWi™
Migration Guide	List the migration guidelines to use the current version of MiWi™
Release Notes	Provides information on release features and enhancements

3. Development environment setup

This chapter provides instructions on how to setup MiWi™ as well as supported IDEs. It also describes the structure of the MiWi™ package and includes references to hardware setup of the supported platforms.

3.1 IDE installation

3.1.1 Atmel Studio

Atmel Studio can be used to develop and debug applications for AVR- and ARM-based platforms. Atmel Studio is equipped with the GCC compiler and does not require any additional external tools to compile and debug MiWi™ applications.

Installation procedure:

- Download and install latest Atmel Studio version, if not already installed on your PC.
- Add path to the folder containing the ARMGCC compiler to the Path Windows environment variable. The compiler is located in the `\Atmel\Studio\7.0\toolchain\arm\arm-gnu-toolchain\arm-none-eabi\bin` directory of the Atmel Studio installation directory. This step is necessary for command line compilation (with makefiles).

3.1.2 IAR Embedded Workbench

IAR Embedded Workbench for ARM can be used to develop and debug applications on ARM-based platforms. IAR IDEs support editing of application source code, compiling source files, linking object modules with libraries and application debugging.

Installation procedure:

- Download and install IAR Embedded Workbench for ARM, if not already installed on your PC
- Add path to the folder containing the IAR RAM compiler to the Path Windows environment variable. The compiler is located in the `\IAR Systems\Embedded Workbench 7.2\arm\bin` directory of the IAR installation directory. This step is necessary for command line compilation (with makefiles).

3.2 Stack Configurations

MiWi™ uses configuration files to regulate the behavior of the stack.

Location of Header Files to fine tune the behavior of P2P application:
1. thirdparty\wireless\miwi\apps\simple_example_p2p\miwi_config.h
2. thirdparty\wireless\miwi\apps\simple_example_p2p\miwi_config_p2p.h

Location of Header Files to fine tune the behavior of Star application:
1. thirdparty\wireless\miwi\apps\simple_example_star\miwi_config.h
2. thirdparty\wireless\miwi\apps\simple_example_star\miwi_config_p2p.h

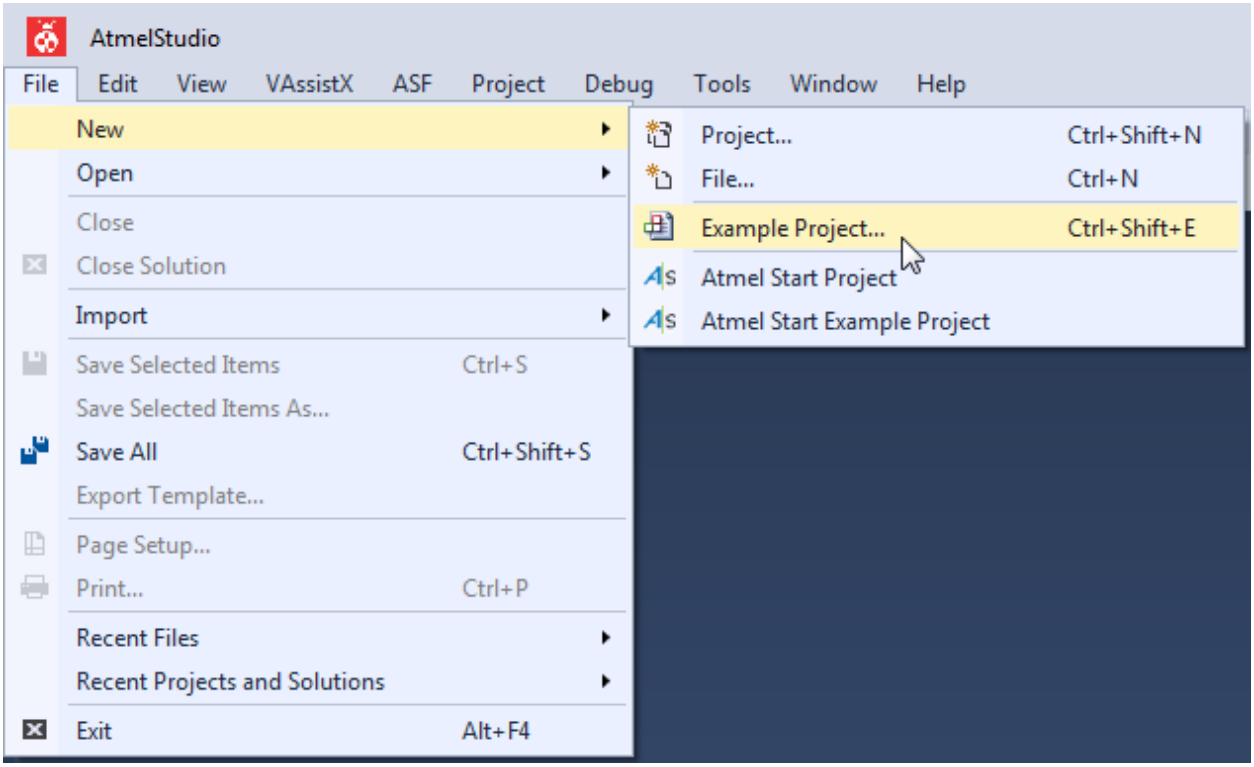
Location of Header Files to fine tune the behavior of Mesh application:
1. thirdparty\wireless\miwi\apps\wsn_demo\miwi_config.h
2. thirdparty\wireless\miwi\apps\wsn_demo\miwi_config_mesh.h

3.3 Building applications in Atmel Studio

Atmel Studio can be used to develop and build MiWi™ applications. Reference applications include Atmel Studio project files located in the `\as5_arm` subdirectory of the application root directory. These projects rely on the configurations given by external low-level makefiles.

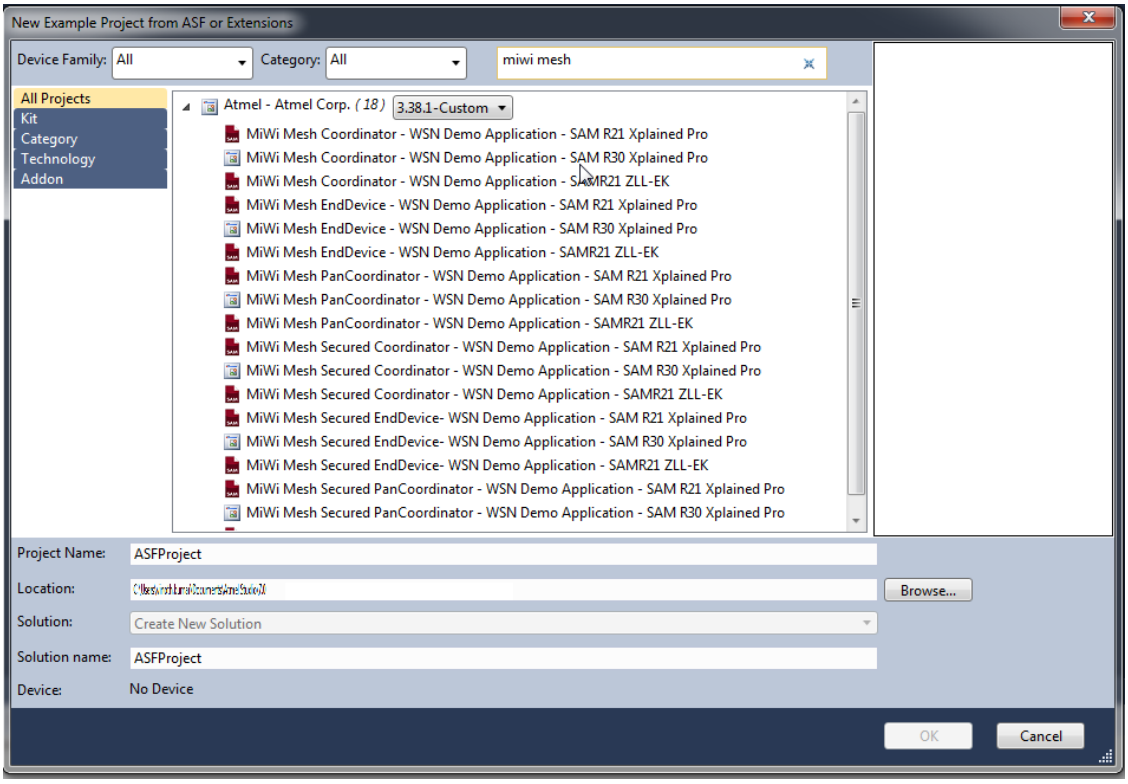
3.3.1 Opening Project from ASF

Open Atmel Studio. Click File->New->Example Project as shown below.

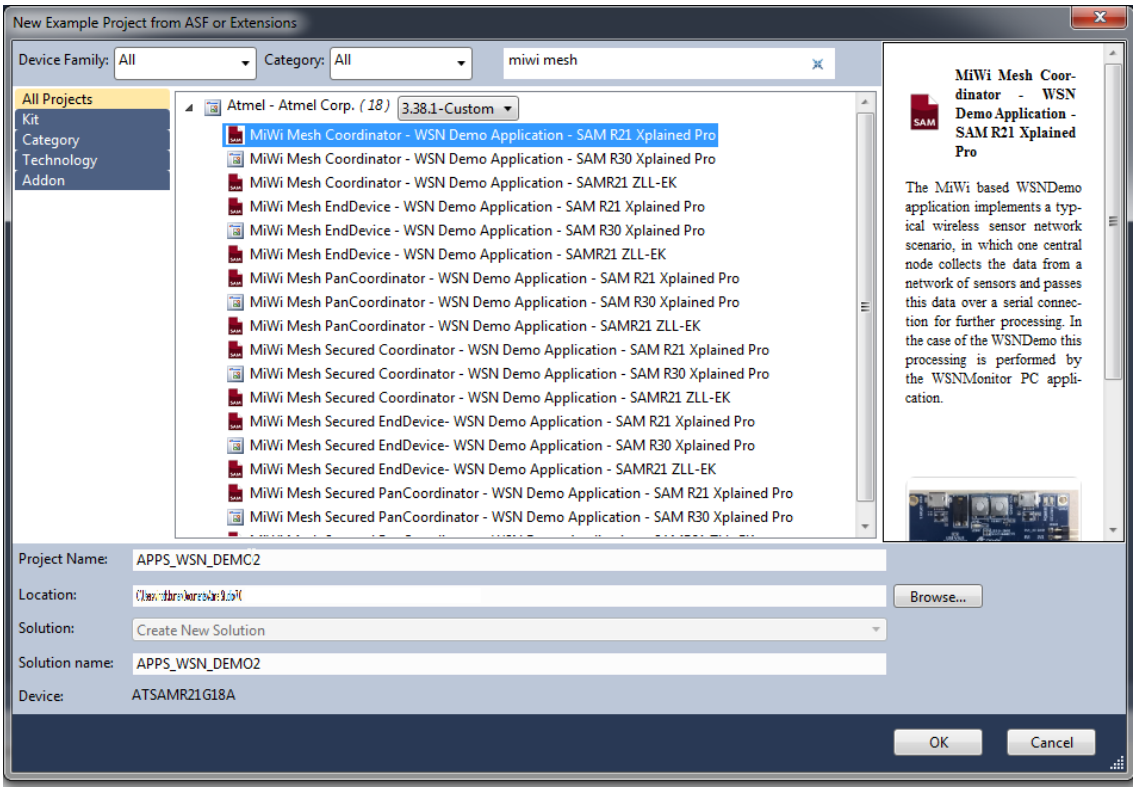


In the opened window, Type “MiWi” to list the list of available projects in MiWi as shown below

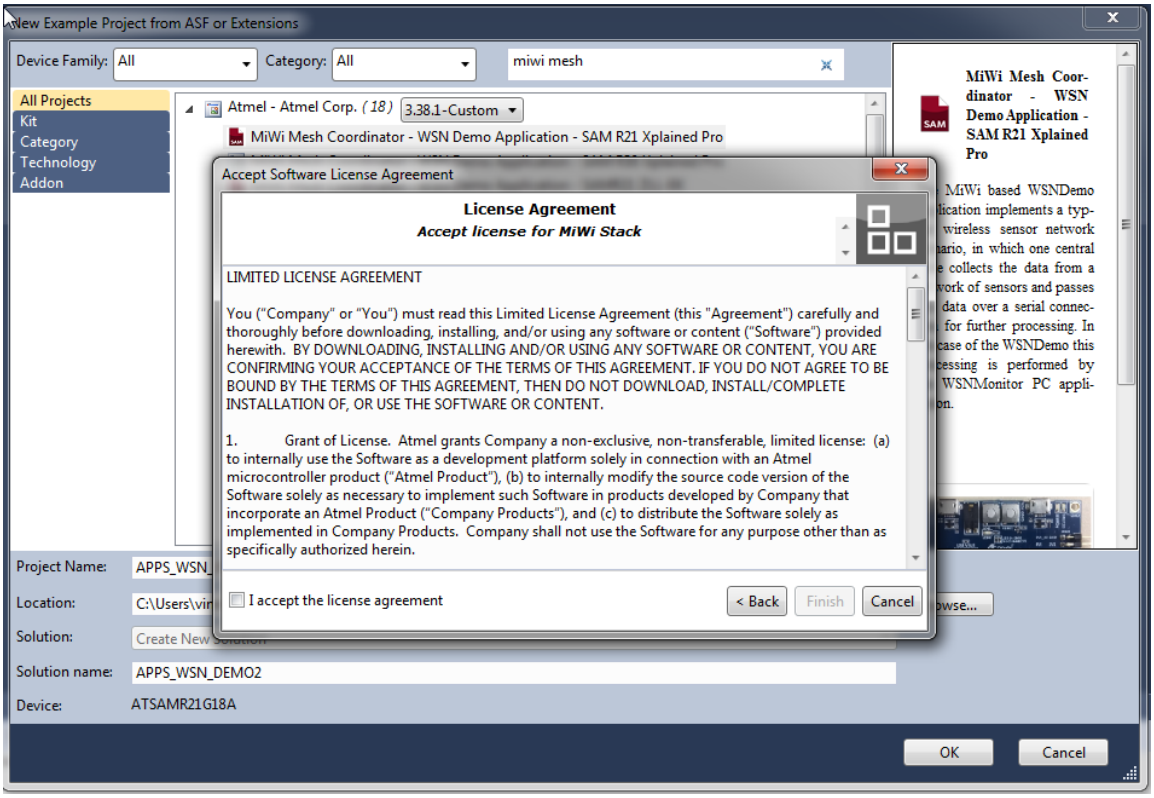
Select a project and Click Ok to open the particular project.



For Example, choose MiWi Mesh PAN Coordinator WSNDemo project.

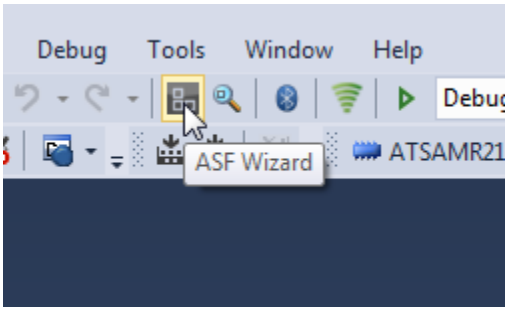


Click ‘Ok’ and accept license agreement, click ‘Finish’.

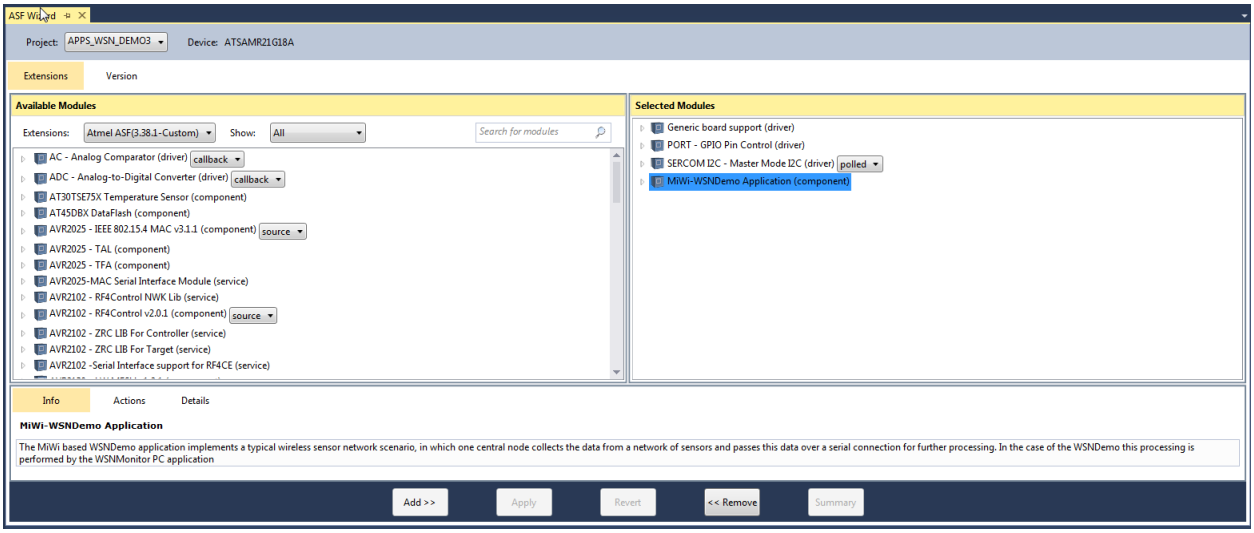


3.3.2 Switching/Changing the configuration using ASF Wizard

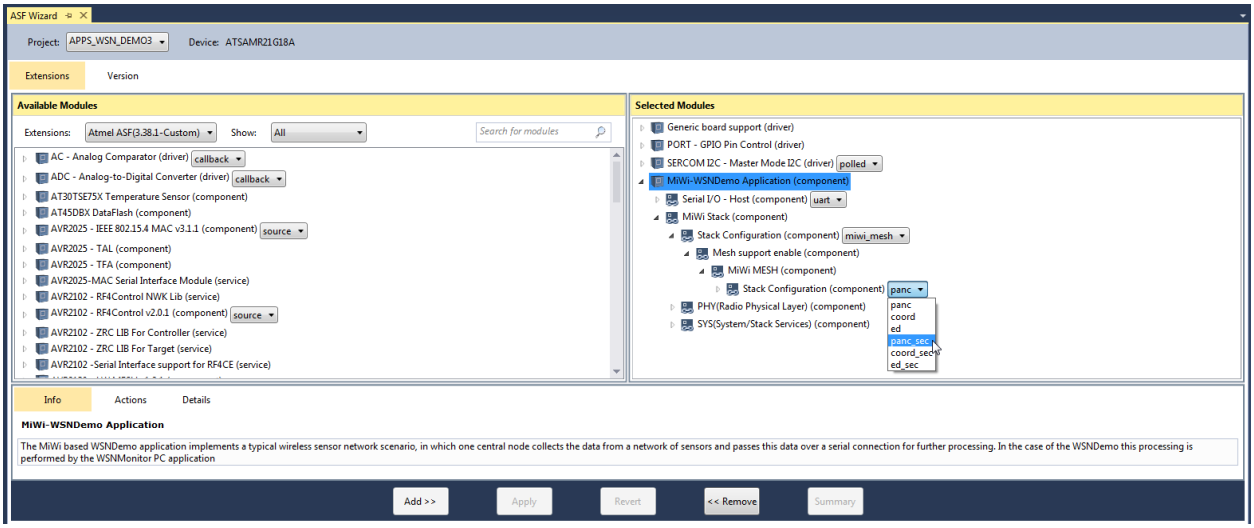
For example, currently you are using MiWi Mesh coordinator and need to switch to MiWi Mesh PANC Security, the follow the below steps.Step 1: Go to ASF Wizard



Step 2: Explore MiWi™ in the selected Modules

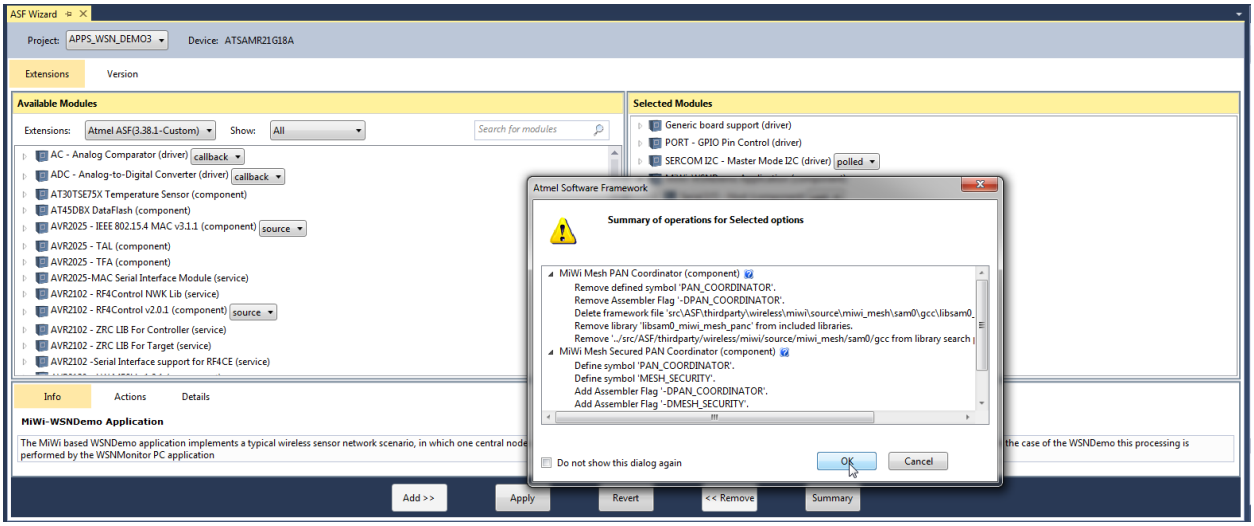


Step 3: Explore to Stack Configuration and select Panc_Sec



Step 4: Click ‘Summary’ to understand the components change

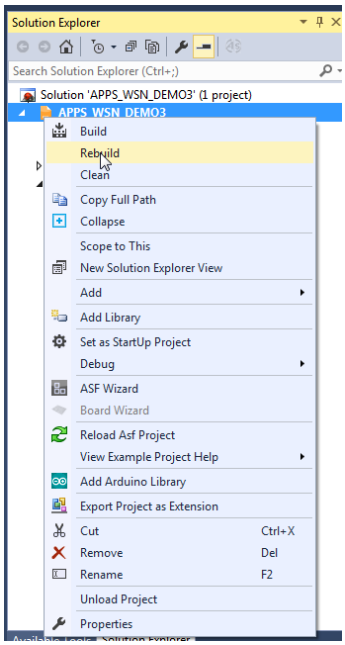
Step 5: Click ‘Apply’ to apply the changes.



3.3.3 Building application from IDE

Open an appropriate `.atsln` project file from the `<appName>\..\as5_arm` directory with Atmel Studio. Solution Explorer tab. This provides access to the application source files as well as stack components that compile together with application.

Example structure of Atmel Studio application project.



From the main menu execute *Build => Rebuild All.*

Once the build process is completed, some of the `.hex`, `.srec`, `.bin`, and `.elf` image files will be generated, depending on the platform configuration that has been chosen. Use the `.hex` file for programming devices via EDBG. The `.elf` file is used for debugging.

3.3.4 Building application from command line

compile the application by running the make utility, executing

```
make clean all
```

It is possible to run the make utility from Atmel Studio by selecting `Tools > Command Prompt`. This will guarantee that the make utility provided with Atmel Studio is used. Otherwise, the path to the folder containing the make utility can be added to the `Path` environment variable. In this case, run the make utility in the command line from the application's root directory.

3.4 Building applications in IAR Embedded Workbench

IAR Embedded Workbench can be used to develop and build Atmel BitCloud applications. All reference applications include IAR project files located in the `\iar` subdirectory of the application root directory.

As mentioned above, a part of stack components and drivers are compiled with the application. For convenience reasons, source files for these components are included in the IAR projects, so they are effectively a part of the application.

For compilation from the command line with the IAR compiler, makefiles are used in exactly the same way as described above.

3.4.1 IDE build procedure

Open the `.eww` file in the iar_projects subdirectory of the appropriate application directory (for WSNDemo, the `APP_WSN_Demo.eww` file from the `apps\WSN_Demo\..\iar` subdirectory) with IAR Embedded Workbench, execute the `Rebuild All` item from the `Project` menu.

By default, the .a90 file (for WSNDemo, `APP_WSN_Demo.a90`) will be generated in the `\iar\Debug\exe` subdirectory (for WSNDemo, in the `apps\WSN_Demo\iar\Debug\exe` directory) with format as specified in Linker Output Options of the IAR project.

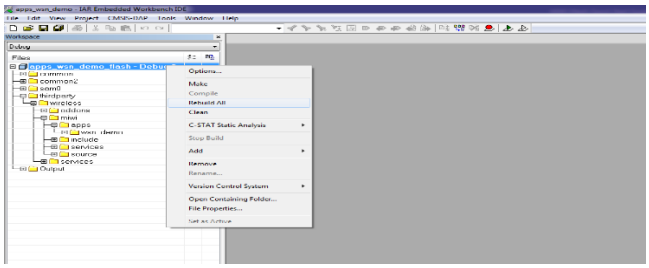
3.4.2 Command line build procedure

Compile the application by running the make utility, executing

```
make clean all
```

Some of the .hex, .srec, .bin, and .elf image files will then be generated, depending on the platform configuration that has been chosen.

Project's structure in IAR Embedded Workbench.

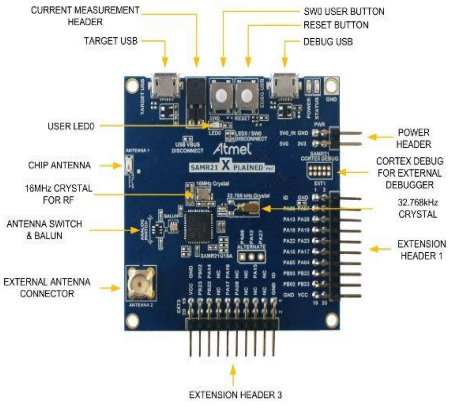


4. Hardware environment setup

4.1 Supported platform and boards

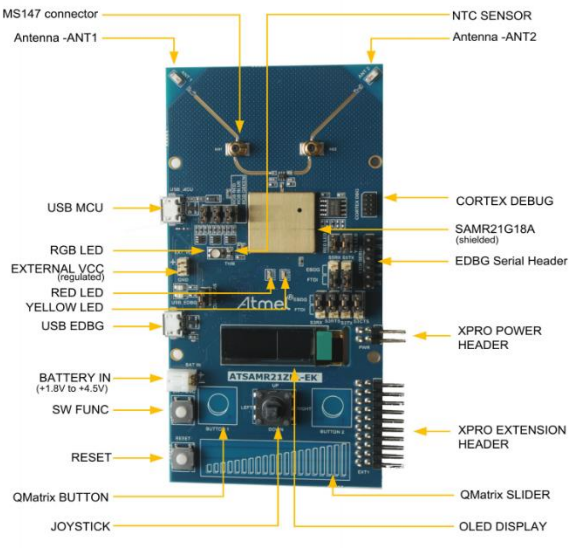
The following boards are used/supported in this release.

- SAMR21G18A
    1. SAMR21 Xplained Pro



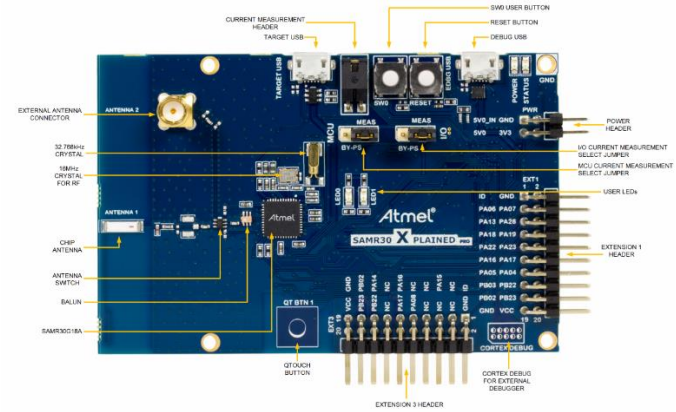
User Guide is available @ http://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-42243-SAMR21-Xplained-Pro_User-Guide.pdf

2. SAMR21 ZLLEK



User Guide is available @ http://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-42462-ATSAMR21ZLL-EK_UserGuide.pdf

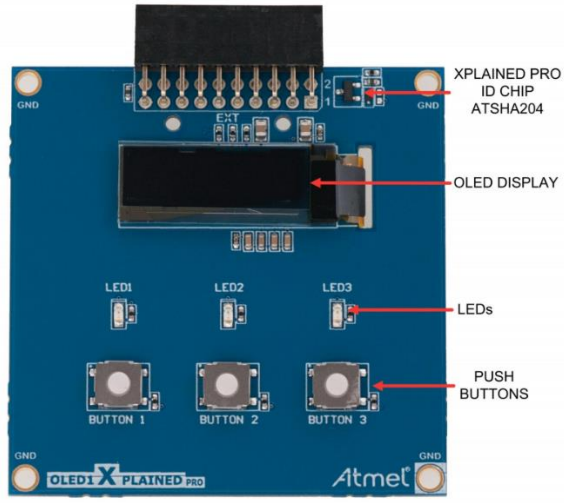
- SAMR30G18A
    1. SAMR30 Xplained Pro



User Guide is available @ http://ww1.microchip.com/downloads/en/DeviceDoc/50002612A.pdf

4.2 Additional boards

For Simple_Example_P2P and Simple_Example_Star applications , OLED1 Xplained PRO can be used as additional board to show the full featured demo on SAMR21 XPRO and SAMR30 XPRO. This board should be connected as Extension board 1 .

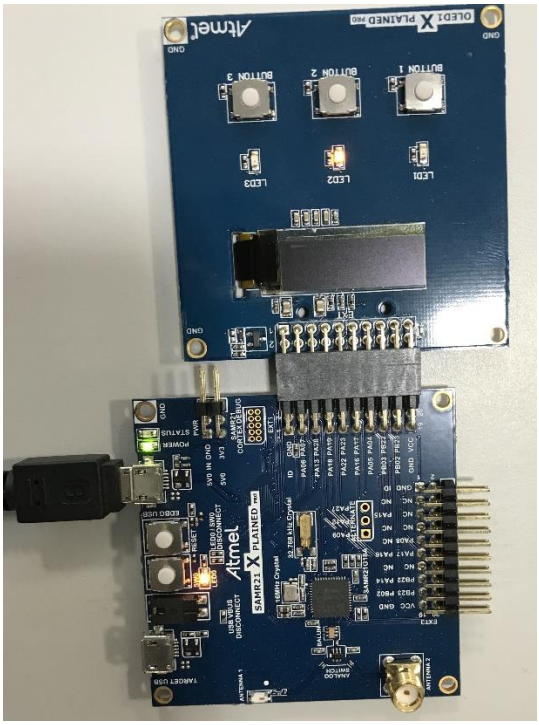


User Guide is available @ http://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-42077-OLED1-Xplained-Pro_User-Guide.pdf

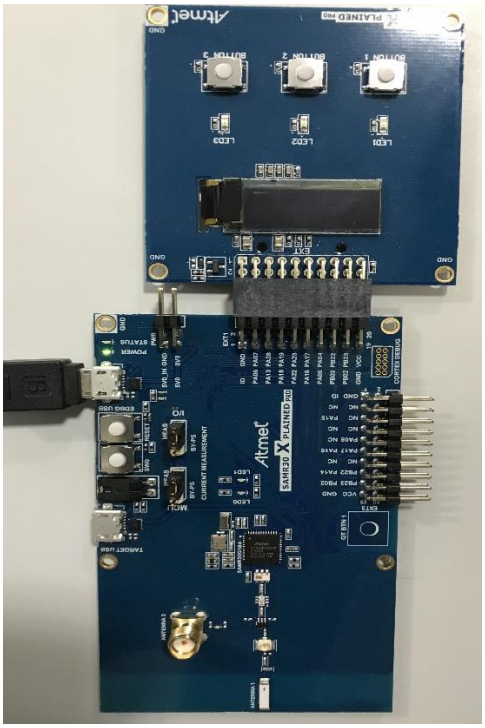
4.3 Connections

Connect Micro USB cable to the ‘Debug USB/EDBG USB’ of the board and connect the other end to the PC.

SAMR21 XPRO+OLED1 XPRO



SAMR30 XPRO+OLED1 XPRO

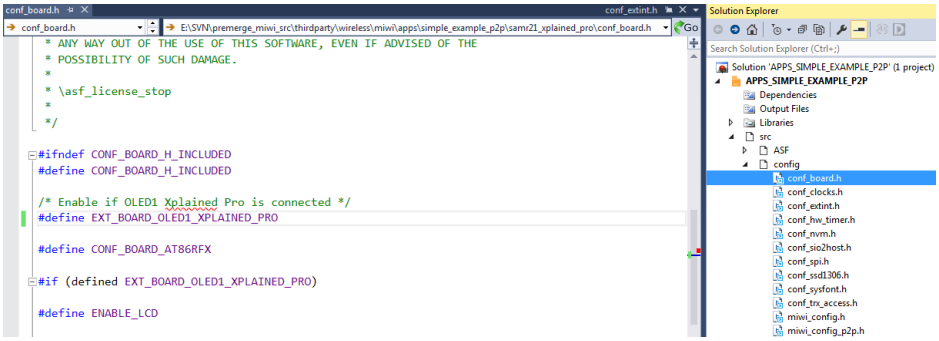


5. Simple_Example_P2P Reference application

The simple example application code focuses on the simplicity of the MiWi™ DE protocol stack application programming interfaces. It provides a clean and straightforward wireless communication between two devices with less than 30 lines of effective C code to run the stack in application layer for both devices. In this application, following features of MiWi™ DE protocol stack have been demonstrated:

- Establish connection automatically between two devices
- Broadcast a packet
- Unicast a packet
- Apply security to the transmitted packet

To run full featured Simple_Example_P2P application on SAMR21 XPRO or SAMR30 XPRO, User needs to connect OLED1 XPlained PRO. When you use OLED1 Xplained PRO along with SAMR21 XPRO or SAMR30 XPRO, then user needs to Enable the macro "`#define EXT_BOARD_OLED1_XPLAINED_PRO`" in conf_board.h file.

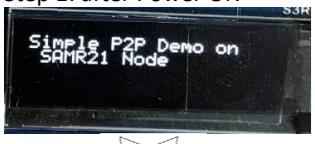


To run the simple example application, follow the instructions given below

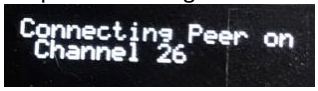
1. Program node 1 and node 2 with proper firmware.
2. Power on node 1 and node 2 respectively
3. Wait a few seconds, until the first LED on both nodes light up. These are the steps to establish connections between two devices.

- This means a connection has been established automatically. For the details of connection establishment, please refer to section "VARIATIONS FOR HANDSHAKING" in application note AN1204 "Microchip MiWi™ P2P Wireless Protocol" if MiWi™ P2P protocol is used, or section "MAC Function Description" in IEEE 802.15.4 specification if MiWi™ protocol is used.
- If the demo is running on SAMR21 ZLLEK (or) SAMR21 XPRO with ATOLED1-XPRO (or) SAMR30 XPRO with ATOLED1-XPRO, critical information will be shown on the LCD of the demo board. It first shows the demo name, RF transceiver and node number, then connecting information and channel information will be shown before the LCD shows the demo instruction

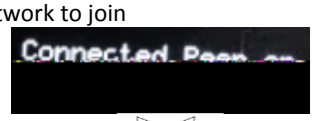
Step 1: after Power ON



Step2: Connecting to a network if found



Step3: Connected to a network(This will not come for first device since it will start network when it is unable to find network to join

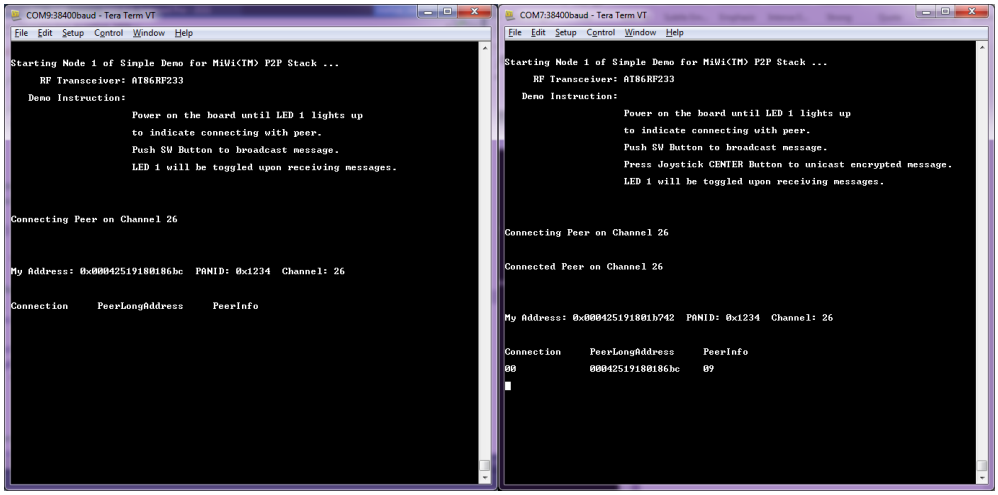


Step4: Demo Instruction will be displayed.

SAMR21ZLLEK **SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO**

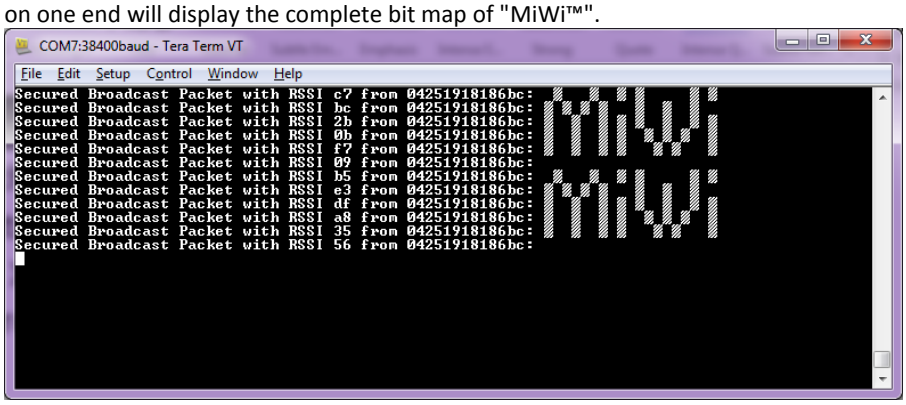
or

- If a hyper terminal has been opened to monitor firmware output, you should be able to see the information about the peer device printed out from both nodes.



4. Press SW/SW FUNC on one node will toggle the second LED on the other node
   - This shows how a broadcast packet has been transmitted.
   - If the demo is running on SAMR21 ZLLEK (or) SAMR21 XPRO with ATOLED1-XPRO (or) SAMR30 XPRO with ATOLED1-XPRO, the total number of transmitted and received messages will be shown on the LCD.

   - If hyper terminal has been used, on the receiving end (the device that has LED2 toggled), you should be able to see the print out of broadcast packet source address, signal strength and the packet payload. The packet payload is the one line of bit map of “MiWi™”. Press the SW button at a interval of 2 seconds between each press on one end will display the complete bit map of "MiWi™".



5. For unicast setup,

SAMR21ZLLEK

Press JOYSTICK center on one node will show

Pressing Joystick DOWN button selects the next device for unicast if available.

Pressing Joystick UP button sends unicast to the selected device and toggle the second LED on the other node.

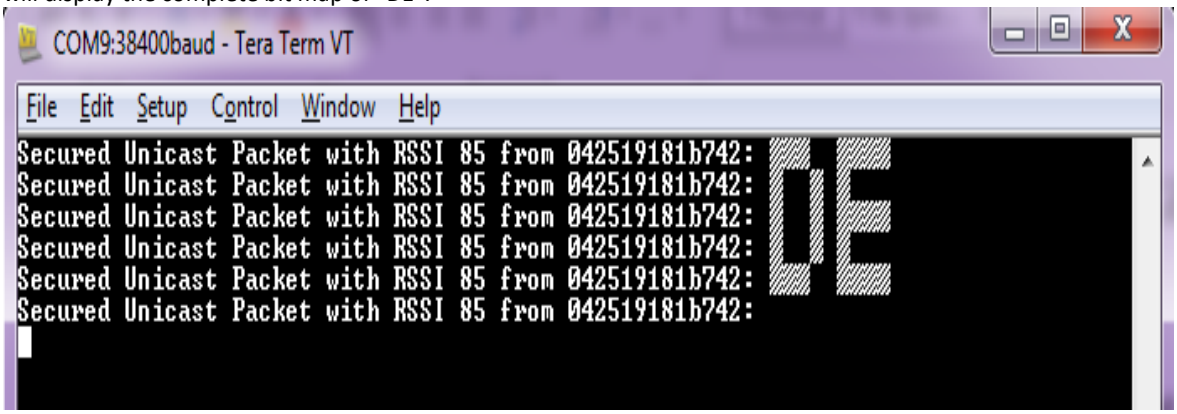
SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO

Press BUTTON1 center on one node will show

Pressing BUTTON1 selects the next device for unicast if available

Pressing SW0 button sends unicast to the selected device.

- This shows how an encrypted unicast packet has been transmitted and decrypted by the radio after it is received. For the details of how MiWi™ P2P handles encryption, please refer to section “Security Features” in application note AN1204 “Microchip MiWi™ P2P Wireless Protocol”.
- If the demo is running on SAMR21 ZLLEK (or) SAMR21 XPRO with ATOLED1-XPRO (or) SAMR30 XPRO with ATOLED1-XPRO, the total number of transmitted and received messages will be shown on the LCD.
- If hyper terminal has been used, on the receiving end (the device that has LED2 toggled), you should be able to see the print out of secured unicast packet source address, signal strength and the packet payload. The packet payload should have been decrypted by the receiving device. The packet payload is the one line of bit map of “DE”. Sending unicasts continuously at a interval of 2 seconds between each unicast/button press on one end will display the complete bit map of "DE".



6. Chat_Demo P2P Reference application

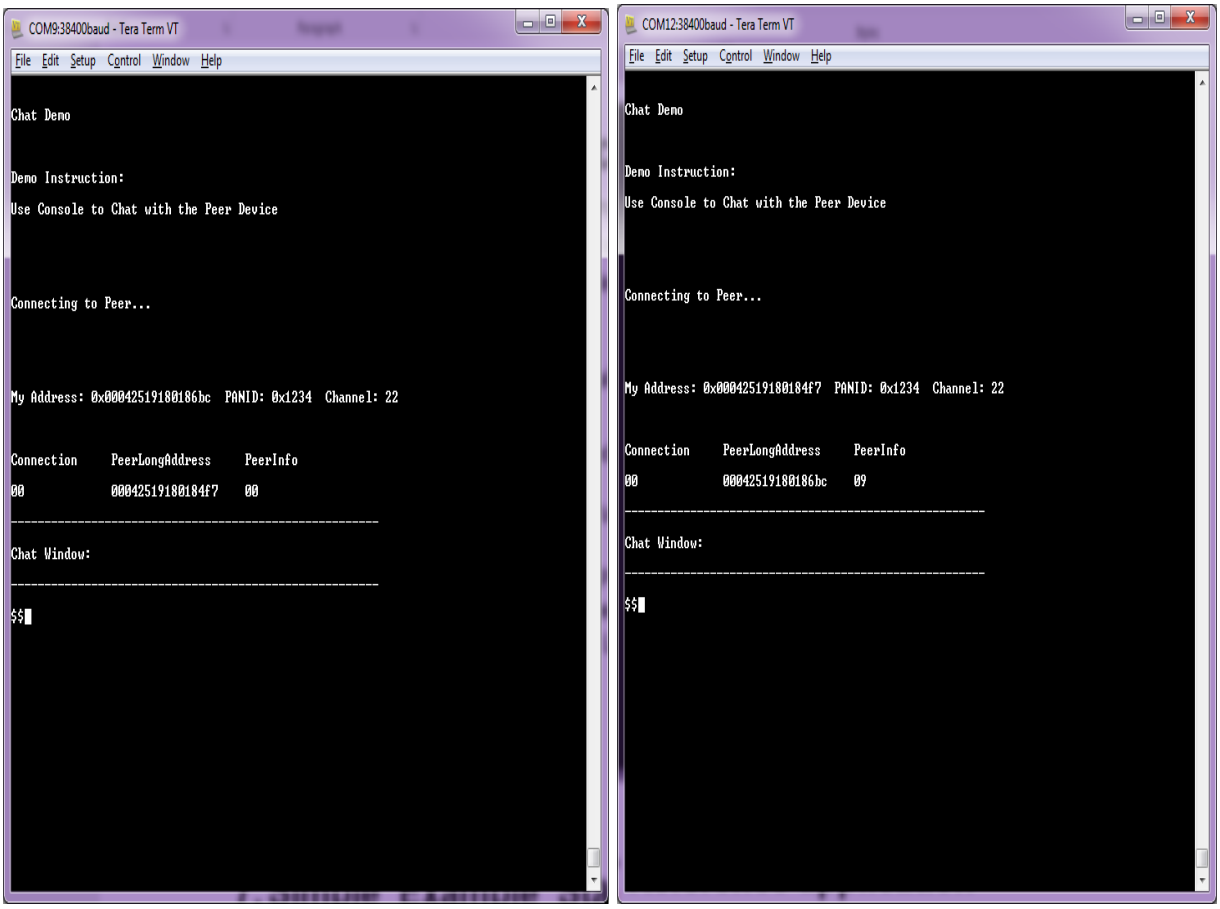
The chat demo P2P application code focuses on the simplicity of the MiWi™ DE protocol stack application programming interfaces. It provides a clean and straightforward wireless communication between two devices with less than 30 lines of effective C code to run the stack in application layer for both devices. In this application, following features of MiWi™ DE protocol stack have been demonstrated:

- Establish connection automatically between two devices
- Unicast a packet
- Apply security to the transmitted packet

To run the chat demo application, follow the instructions given below

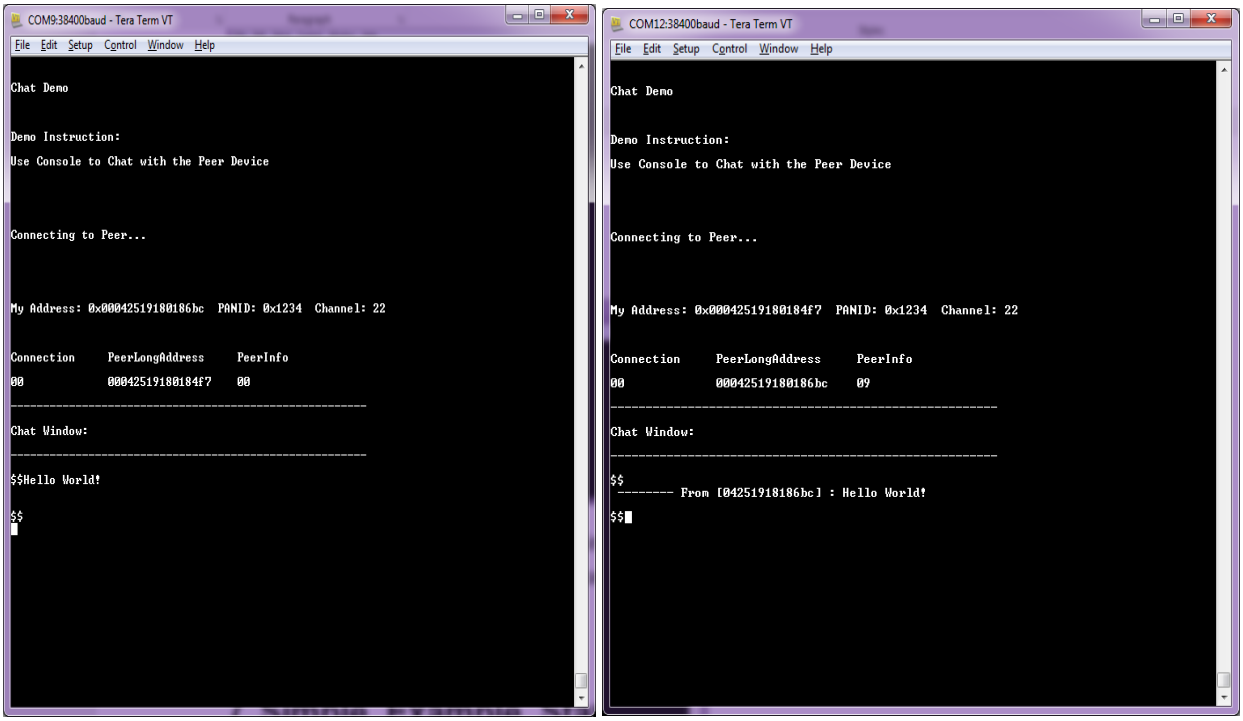
1. Program node 1 and node 2 with proper firmware.
2. Power on node 1 and node 2 respectively, a hyper terminal has to be opened to monitor firmware output.
3. Wait a few seconds, until the first LED on both nodes light up. These are the steps to establish connections between two devices.
4. Now you should be able to see the information about the peer device printed out from both nodes.

Node 1 **Node 2**



6. Once the devices are connected, start typing and press enter. For example type ‘Hello World!’ on node 1 and hit enter, you should be able to see the entered text on node 2 like below.

Node 1 **Node 2**



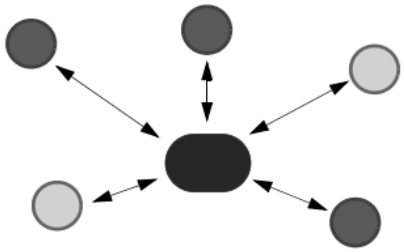
7. Simple_Example_Star Reference application

The simple example application code focuses on the simplicity of the MiWi™ DE protocol stack application programming interfaces. It provides a clean and straightforward wireless communication between two devices with less than 30 lines of effective C code to run the stack in application layer for both devices. In this application, following features of MiWi™ DE protocol stack have been demonstrated:

- Establish connection automatically between two devices
- Broadcast a packet
- Unicast a packet from one node to another through Pan Coordinator.
- Apply security to the transmitted packet.

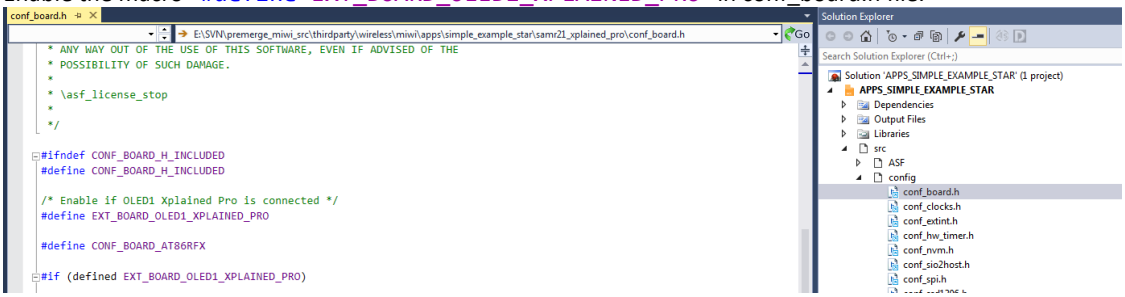
Star Network is supported on 3 different Hardware Development Boards and works the same way as discussed below for all the configurations.

Star Network Configuration

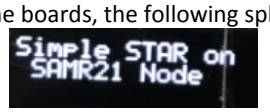


DEMO OPERATION

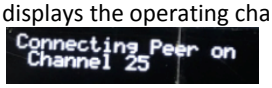
To run full featured Simple_Example_Star application on SAMR21 XPRO or SAMR30 XPRO, User needs to connect OLED1 XPlained PRO. When you use OLED1 Xplained PRO along with SAMR21 XPRO or SAMR30 XPRO, then user needs to Enable the macro "`#define EXT_BOARD_OLED1_XPLAINED_PRO`" in conf_board.h file.



1. On powering the boards, the following splash screen message will be displayed on the LCD screen.

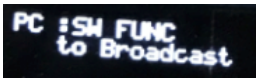


2. The LCD screen displays the operating channel

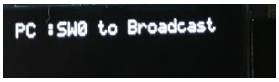


3. If no network is found, the node creates its own network and acts as a MiWi™ PAN Coordinator. The LCD display changes to:

SAMR21ZLLEK



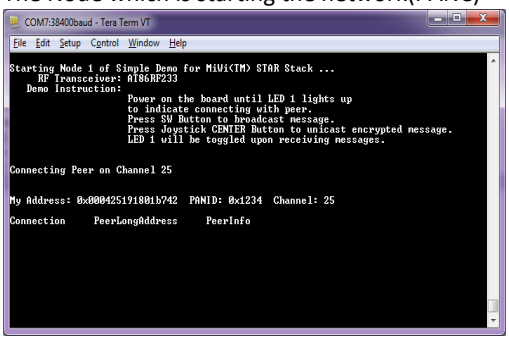
SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO



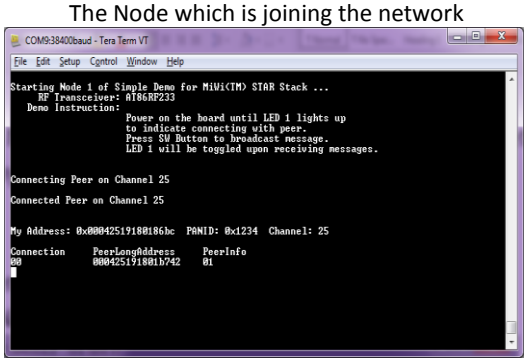
4. If any other MiWi™ PANCO node is found in the vicinity, then it gets connected to the PAN Coordinator as End Node. The LCD display changes to

Hyper terminal shows below upon successful connection.

The Node which is starting the network(PANC)



The Node which is joining the network

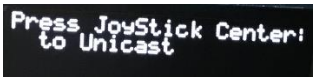


Note:

For every 15 seconds, PAN CO broadcasts the connection table to all the end nodes and End nodes sends the link status to PAN CO. After the PAN Coordinator has established a network, power on a second node and follow the instructions in step #5 above to join the PAN Coordinator.
This process may be repeated to add any number of Nodes to the network.

5. After getting connected to PAN Coordinator, the LCD displays options to Unicast a message to either the Pan Coordinator or to another Node in the network.

SAMR21ZLLEK

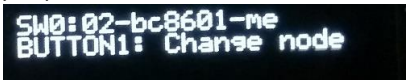


If you press Joystick Center button

Pressing Joystick **UP** sends the unicast message.

SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO

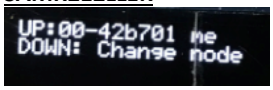
If you press BUTTON 1 will show the next node to choose



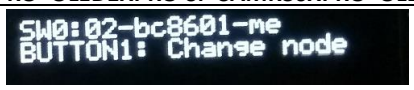
Pressing SW0 button sends the unicast message.

7. Pressing Joystick DOWN push button on the Node on SAMR21ZLLEK or Pressing BUTTON 1 on SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO, displays the address of the next node in the Unicast address selection list. The LCD Screen will display the three bytes of short address followed by “me” keyword indicating its own MAC address in the list, or MAC address of the next node in the Unicast address selection list. Depending on the location within the list, the LCD screen will show one of the following text:

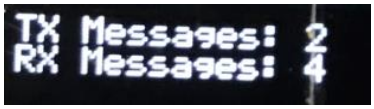
SAMR21ZLLEK



SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO



7. Now if Joystick UP push button on SAMR21ZLLEK or SW0 on SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO is pressed at End Node, a unicast message is sent to PAN Coordinator in the case of xx-xxxxxx-me or to the destination node as indicated by xx-xxxxxx. After a successful transmission, the TX value gets incremented at the source End Node. The RX value gets incremented at the destination node (PAN CO) and three bytes of source MAC address is displayed.
At the source End Node the LCD will display:



At the Destination Node:

After One second the display changes to

8. If Joystick DOWN push button on SAMR21ZLLEK or BUTTON 1 on SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO is pressed at End Node, the LCD displays the next node present in the connection table.

UP: 01-XXXXXX

DOWN: Change Node

Note: At End Nodes, UP push button on SAMR21ZLLEK or SW0 button on SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO is used to unicast message to the selected node. DOWN push button on SAMR21ZLLEK or BUTTON 1 on SAMR21XPRO+OLED1XPRO or SAMR30XPRO+OLED1XPRO is used to change/select the other destination node of the unicast message.

9. Press SW button at PAN CO to broadcast message to all the End nodes in the network. The LCD displays the incremented TX value.

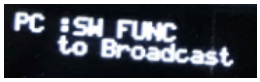
TX: xx , RX: yy

Message Count

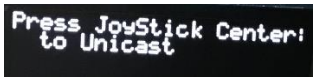
Note: Whenever the destination node receives the message from source (End Nodes or PAN CO) RX value gets incremented. The respective nodes display the three bytes of source MAC address from which they have received the message.

10. After few seconds the display reverts back to following messages on the LCD Display

At PAN CO:

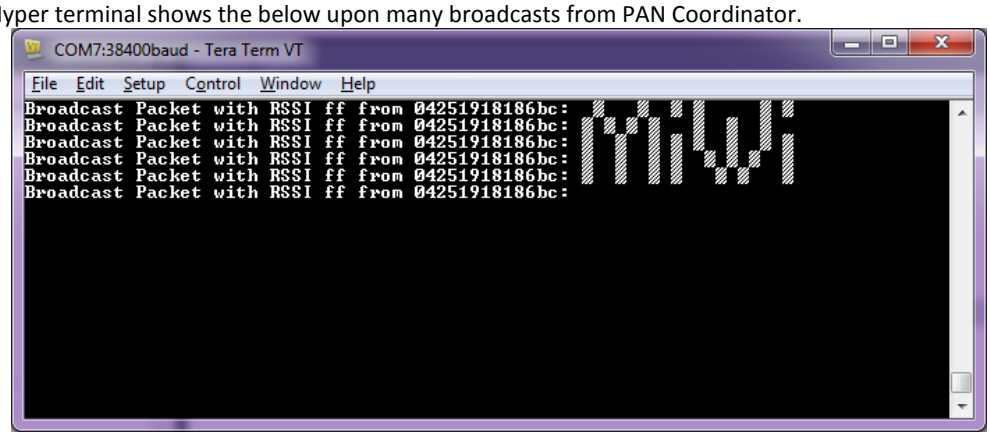


At Source or Destination End Nodes:



If power is recycled on an End Node, the description given below may be used to restore the node onto the network using the “Freezer” option.

Hyper terminal shows the below upon many broadcasts from PAN Coordinator.



8. WSN Demo Mesh Reference application

8.1 Overview

The network and radio frequency performance of the hardware components is demonstrated with the WSNDemo application, which is based on the MiWi™ API.

This application consists of the embedded firmware, which supports functions for PAN Coordinator, Coordinator, and End device, and the GUI visualization application, WSNMonitor, which is run on a PC. In WSNDemo, the nodes communicate based on a proprietary messaging protocol.

The package includes the WSNMonitor PC application in binary format and the WSNDemo embedded application is available in binary format and source code.

The source code for the WSNDemo application can be modified and extended, making it possible to develop WSN applications for a variety of application scenarios.

End devices, coordinators, and the PAN coordinator devices emulate the sensor data reading for light and temperature sensors, and forward collected data to the WSNMonitor application for visualization.

End devices follow a duty cycle to transmit data to the coordinator. Using the serial connection, the PAN coordinator transmits the received packets, along with its own sensor data (or emulated sensor data), to the WSNMonitor application. Those transmitted values are displayed on WSNMonitor panes as temperature, light, and battery level measurements.

WSNMonitor also visualizes network topology by drawing a tree of nodes that have joined the network. For each of the nodes, parameters like node address, node sensor information, and link quality data are displayed.

RSSI indicates a link's current condition and is measured in dBm. The RSSI resolution is 3dBm. LQI, a numeric parameter defined within the 0 to 255 range, is used to measure the link quality. Larger values mean a better link, while values close to zero indicate a poor connection.

8.2 Launching the demo

1. Assemble devices

2. Program devices with firmware images. One node shall be programmed as PAN coordinator, others as coordinators or end devices.

3. Connect the PAN coordinator node to the PC using the serial interface.

4. Run WSNMonitor

Use the following setting for the serial connection of the WSN Monitor:

`BAUD RATE: 38400`

`PARITY: None`

`DATA BITS: 8`

`STOP BITS: 1`

`FLOW CONTROL: Off` (`On` for the XPRO board)

5. Observer coordinator node in the WSN Monitor.

6. Power on the rest of the nodes and observe them displayed in the WSNMonitor.

7. Select any coordinator node and click on the bulb icon next to it, observe the device to blink its LEDs.

8.3 Network startup

The PAN coordinator organizes the wireless network automatically. Upon starting, every node informs the network of its role. When the PAN coordinator is powered on, it switches to an active state even though no child node is present. This is normal, and it indicates that the PAN coordinator is ready and that child nodes can join the network with the coordinator's PAN ID. By default, the coordinator uses PAN ID 0x1234, which is recognized by all coordinators. The PAN ID can be modified by the user through the application's configuration file.

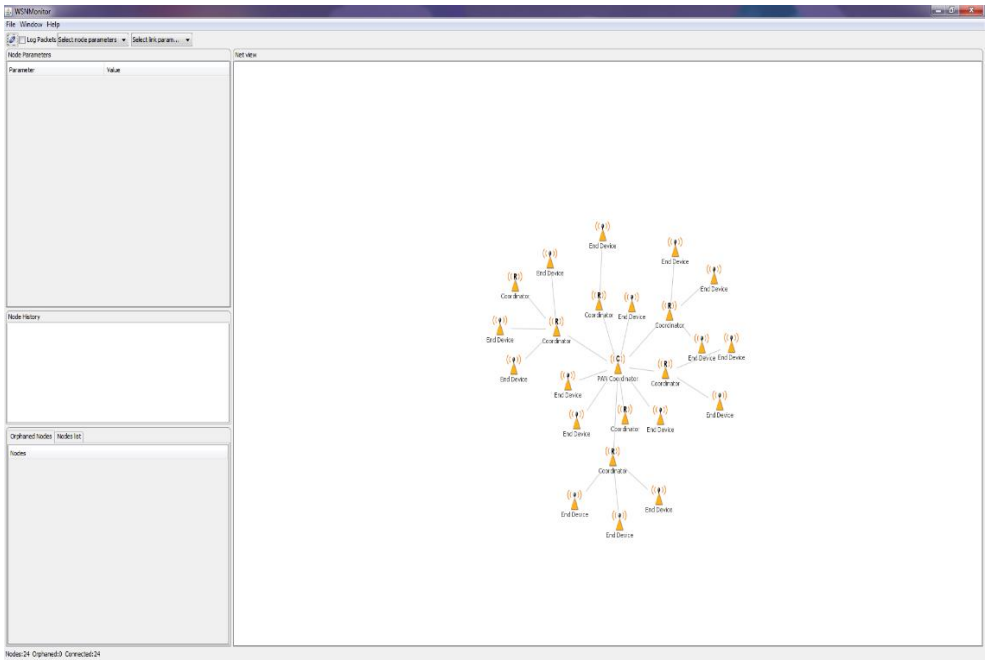
If the PAN coordinator is absent or has not been turned on, the coordinators and end devices will remain in the network search mode. In this mode, coordinators scan the channels specified in the channel mask in search of a network. By default, the channel mask in application provided with the release contains a single channel. In rare cases, if the frequency corresponding to the radio channel is busy, the coordinator node may stay in the network search mode. If this happens, it may become necessary to change the application's channel mask to select another channel by changing the application's configuration file and recompiling the application.

Network health can be monitored through the WSN Monitor application described in the next section.

8.4 WSNMonitor

WSNMonitor is a PC counterpart to the WSNDemo embedded application, and can be used to display MiWi™ Mesh network topology and other information about a wireless sensor network. A typical WSN Monitor screen is shown below. It contains topology, sensor data, and node data panes and application toolbars.

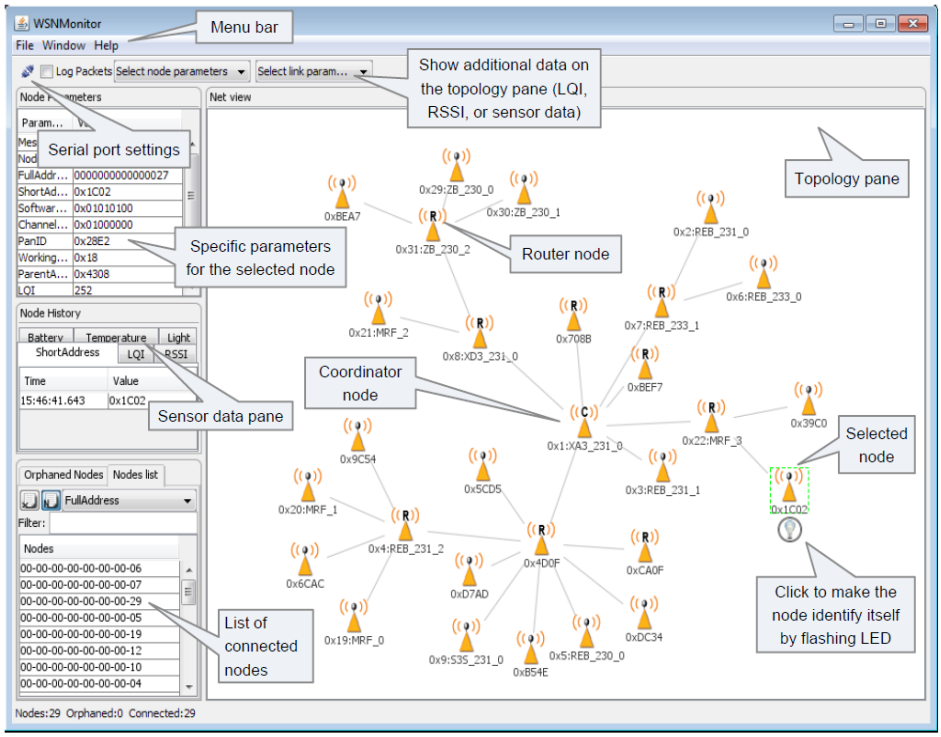
Example Topology of MiWi™ Mesh protocol is shown below:



The topology pane displays the network topology in real time, which helps the user monitor the formation of and dynamic changes in the network while nodes join, send data across, or leave the network. The network topology is constructed on the basis of next-hop information for each of the nodes, and each link is also tipped with RSSI and LQI values. Each of the nodes displayed is depicted by an icon, with the node's address or name below and sensor readings to the right of the icon, if required by settings.

The sensor data pane displays data coming from onboard sensors of the selected node. It is presented in graph and table form. Other parameters can be observed for each node in table form. The node data pane includes a sensor selection combo-box, which is used to switch between sensor types.

By default in the topology pane, nodes are labeled with their short addresses. However, another title can be assigned to any desired node by a double click. If "Cancel" is pressed in the opened window, the node's title is set back to the short address.



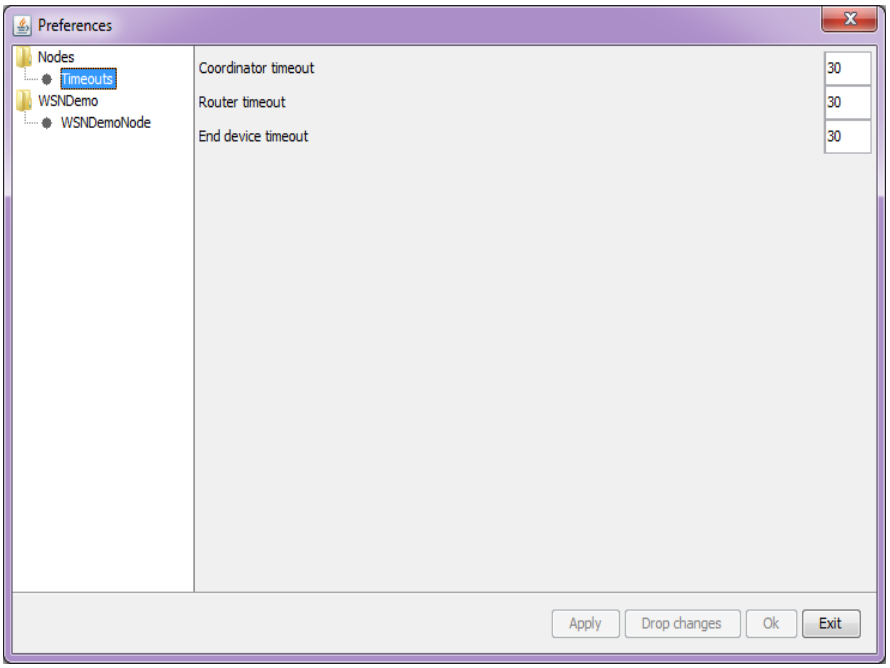
8.5 Identifying nodes

When a user clicks a node in the topology pane a button that can be used to identify the node appears under the node's icon. When the user clicks this button WSNMonitor sends a command, which is delivered to the PAN coordinator through the serial connection and wirelessly to the target node. The target node, receiving the command, blinks with its LED for several seconds.

8.6 Node timeouts

The Window/Preferences menu of WSNMonitor contains a number of parameters used to control application behavior. Timeouts are used to tune visualization of PAN Coordinator, Coordinator, and end devices as the nodes disappear from the network each time a connection is lost, power is down, or a reset has occurred. A node timeout corresponds to the time the WSNMonitor application waits for a packet from a particular node before assuming that the node is no longer part of the network. Note that this value does not correspond to the frequency with which data are transmitted by each type of device. To get smooth topology visualization, setting timeouts to 20 seconds is recommended for PAN Coordinator, and Coordinator, and 30 seconds is recommended for an end device. Assuming a default application configuration, these timeouts cover three periods between sending a packet, and so at least three packets would need to be lost before a node is removed from the WSNMonitor topology pane.

WSN Monitor preferences menu



8.7 Sensor data visualization

Each board sends temperature/light/battery sensor readings (or emulated values) to the PAN coordinator, which in turn sends it to the PC. WSNMonitor displays the readings from onboard sensors next to a node icon inside the topology pane. A corresponding option can be selected in the node/link parameters from the quick settings toolbar.

The user can select any node in the topology pane to monitor the node's activity and see the node data in one of three different forms:

Text table

Chart

The onboard sensor's data displayed next to each node in the topology pane. These values are also tipped with arrows indicating whether the value increased or decreased in relation to the previous sample. A given node is selected when it is clicked on and a dashed frame is visible around it.

The same values are shown on the sensor data pane, enabling the user to observe how the values change over a period of time. The sensor data pane includes a sensor selection combo-box. Use the button on the sensor control toolbar to display the desired types of sensor data.