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USERS GUIDE

EK2500 Evaluation Kit

for SNAP and Portal Version 2.4
Document Revision v1.7

1.   Before Getting Started

You've come to the right place: This manual is a tutorial introduction to the Synapse SNAP product line, and you should definitely read through it and try out all of the hands-on examples it contains.

When you have completed this manual, you will have:

- gotten familiar with the included SNAP hardware
- installed the companion Portal software and any needed device drivers
- gotten familiar with the basics of using Portal and SNAP to develop wireless applications

Because it is intended to be a **tutorial**, you need to read through it *in order*, as opposed to skipping around within the document. You also need to *actually do the steps* as specified, because later sections assume the steps from previous sections have been completed.

This manual also focuses on the components actually included in the kit, rather than trying to cover all the different types of SNAP hardware that are available. Just be aware that there exist other types of SNAP-compatible hardware than what you see included in this kit.

Finally, be aware that this manual is a starting point if you will, just one piece of a much larger set of documentation.

Other Documentation

This document, the EK2500 Evaluation Kit Users Guide, is only one of several featured with this evaluation kit. (Several documents are also installed on your system when you install Portal, which you will do as part of this tutorial.) Be sure to also take a look at:

- The "SNAP Primer"   (600037-01D)

   This document contains an introduction to SNAP and explanations of how mesh networking works. It also introduces the various Synapse software and hardware available, and clarifies the naming conventions used for the various SNAP items.

- The "SNAP Users Guide"   (600025-01A)

   This document is where you will find an explanation of how the components in a SNAP network work together, with introductions to topics like hook handling and with sample scripts.

- The "SNAP Reference Manual" (600-0007N)

This document is where you will find information on the built-in functions provided by Portal and SNAPpy. It also provides information specific to each platform to which SNAP has been ported.

- The "SNAP Sniffer Users Guide" (600026-01B)

Starting with Portal version 2.2.23, a "wireless sniffer" capability is included with Portal. If you follow the instructions in this standalone manual, you will be able to actually *see* the wireless exchanges that are taking place between your SNAP nodes.

- The "Portal Reference Manual" (600024-01G)

This document contains lots of information on how to use Portal, the software that runs on your PC and allows you to configure and manage your wireless network.

Additionally, you may wish to refer to the following hardware guides:

- The "SNAP Hardware Technical Manual" (600-101.01D)

Every switch, button, and jumper of every SNAP board is covered in this hardware reference document.

- The "End Device Quick Start Guide" (600-0001A)
- The "SN171 Quick Start Guide" (600-0011C)

These two documents are subsets of the "SNAP Hardware Technical Manual" and come in handy because each focuses on a single board type.

All of these documents are in Portable Document Format (PDF) files and are available on the Synapse Wireless forum website.

Other Sources of Information

There is a dedicated support forum at http://forums.synapse-wireless.com.

In the forum, you can see questions and answers posted by other users, as well as post your own questions. The forum has examples and Application Notes, waiting to be downloaded.

The forum also contains all the latest copies of the documentation included with this kit, plus the latest versions of Synapse Wireless software. Be sure to download the newest version of Portal (which includes the most recent firmware) for the latest feature set.

Also be sure to check out the Synapse website at www.synapse-wireless.com.

2. Getting Started

Overview

The Synapse *SNAP* product family provides an extremely powerful and flexible platform for developing, deploying and managing wireless applications.

SNAP is the name of our network operating system. The word is also used somewhat generically to refer to the entire product line. Often when we are talking about SNAP we are implicitly including SNAP, SNAPpy, Portal, and SNAPconnect.

A *SNAP* network consists of individual SNAP nodes. At the heart of each node included in this kit is a Synapse SNAP Engine, or some other equivalent SNAP Device.
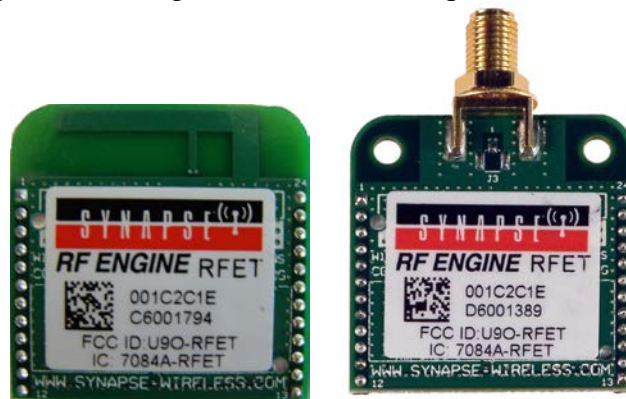
Each SNAP Engine combines a microcontroller, a radio, and an antenna. The antenna can either be an integral "F" antenna, or a mounting point for an external antenna. The exact hardware included in your evaluation kit may vary, depending on the platform around which your kit was built. It may be based on RF100 SNAP Engines (also known as RF Engines), as pictured above, or RF200 or RF300 SNAP Engines. RF100 and RF200 SNAP Engines communicate using 802.15.4 2.4 GHz radio signals, while RF300 SNAP Engines are used for sub-gigahertz communications (900 MHz, 868 MHz, etc.). Additionally, there are EK2500 kits available that showcase the hardware of other vendors (for example Panasonic). This alternate hardware still runs SNAP.

Each SNAP Engine has an on-board microcontroller with its own internal RAM and ROM. No external components are required for operation.

Each SNAP Engine includes General Purpose I/O (GPIO) pins, which can be configured as digital inputs or outputs. Many of these same GPIO pins can also be switched to alternate functionality. The exact number pins and how they can be repurposed will vary from platform to platform, but each SNAP Engine will be able to support:

- analog inputs, providing 10-bit resolution (or better)
- serial data lines (one or two UARTs, depending on platform)
- serial handshake lines (one RTS and one CTS per UART)

Although up to 20 I/O pins are available, you only have to hook up the exact functionality required by your application. The *minimal* hookup to an SNAP Device consists of two wires:

- One wire for VCC (2.7-3.4 volts DC)
- One wire for GND

The SNAP Engines contain core code (written in C) that implements basic wireless networking functionality. This core code also implements a *virtual machine* that executes a subset of the Python programming language. Synapse has named this subset of Python **SNAPpy**.

> You can find details on the SNAPpy language, and how it compares to Python, in the "SNAP Users Guide" and the "SNAP Reference Manual." For now, the important point is to understand that SNAP nodes support a scripting language.

SNAPpy scripts can be uploaded into SNAP Engines "over the air" (OTA), or over the serial interfaces. These scripts define the personality of each node; by changing the SNAPpy script in a node you change the node's behavior.

SNAP Engines can be designed into your own products, acting as a slave device to your main microcontroller or microprocessor. In many cases the SNAP Engine can take over the functionality of the original main processor, in *addition* to adding wireless capability and SNAPpy scripting.

In addition to discrete SNAP Engine modules, Synapse also sells SNAP **demonstration boards** that extend the basic core capabilities with additional I/O hardware.

Three different kinds of SNAP demonstration boards are included in this evaluation kit:
- One SN111 End Device Demonstration Board
- One SN171 Proto Board
- Depending on the hardware platform around which the kit is based it will include *one* of the following:
  - One SS200 SNAP Stick USB Dongle
  - One SN132 SNAP Stick USB Carrier Module

Details about each of these boards can be found in the "SNAP Hardware Technical Manual."

A Portal into Your Network

Portal is a standalone software application that runs on any standard PC with Microsoft Windows 2000 or higher[1]. Using a USB or RS232 interface, it connects to any SNAP Engine in the SNAP Wireless Network, becoming a user interface for the entire network.

Note: most of the icons shown in the previous diagram were taken directly from the Portal user interface.

is used (by default) within Portal to represent a SNAP Node.

is used within Portal to represent Portal itself.

Once connected, Portal provides the capability to *interactively* build an *intelligent* wireless network. You can:

- Discover new SNAP Devices
- Upload *intelligence* to those devices over the air, using SNAPpy scripts
- Customize Portal to suit your specific application

Interactively – you do all this within Portal, observing the results immediately.

Intelligent – the network is purpose-built for your application, with the ability to monitor and conditionally control things connected to it.

Synapse's **Portal** administrative software is included in this evaluation kit.

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[1] Portal also runs on the latest long-term release of Ubuntu Linux, and on the latest Macintosh OS. There may be minor cosmetic differences in the UI appearance, but the functionality is the same across operating systems.

For more information about using Portal, refer to the "Portal Users Guide."

Throughout this manual, the term "Portal PC" is used to refer to the PC (Windows, Linux or Macintosh) that Portal is running on. Screenshots in this document show Portal running in a Windows environment, but Portal's functionality is consistent across the platforms.

Note:
Synapse also licenses a standalone *SNAP Connect* library, giving you access into your SNAP network. Import the SNAP Connect library into your Python application to allow your backend systems to participate seamlessly in the SNAP network.

Evaluation Kit Hardware

To demonstrate many of the capabilities of Synapse **SNAP Engines**, **SNAP** and **Portal**, we've bundled them together in an evaluation kit form – the EK2500.

The hardware included in the standard kit is (clockwise, from upper left) power supply, serial cable, power supply, AA battery holder, SN111 End Device Demonstration Board, SS200 SNAP Stick USB Dongle and SN171 Proto Board. (Depending on the platform on which your kit is based, you may have a SN132 SNAP Stick USB Carrier Module, shown at right, with an additional SNAP Engine instead of the SS200 SNAP Stick USB Dongle.)

The EK2500 evaluation kit comes with software, power supplies, external battery holder, and an RS232 serial cable. Although not shown in the photo, the kit also comes with one pair of AA batteries. The kit also contains *three different kinds* of SNAP boards:

- One SS200 SNAP Stick USB Dongle or SN132 with SNAP Engine
- One SN111 End Device Demonstration Board
- One SN171 Proto Board

Each type of node in the EK2500 evaluation kit has been included to showcase a different set of SNAP traits. Each one has different strengths, and you will likely be building your final wireless network using a *mix* of the different node types. It is also possible to directly incorporate the Synapse SNAP Engines used by these "demonstration" nodes into your own designs.

Furthermore, the demonstration boards in the EK2500 kit provide different approaches to demonstrating how the nodes can be used. In your own hardware designs, it is *not* necessary that you incorporate SNAP demonstration boards in order to use SNAP Engines.

### NOTE! Kit contents might be slightly different!

Some older versions of the EK2500 kit included the following hardware:
- One SN163 Bridge Demonstration Board
- One SN111 End Device Demonstration Board
- One SN171 Proto Board

For the demonstrations contain in this guide, if you have an older kit simply use the SN163 bridge board where references are made to the "SNAP Stick".

SN111 End Device Demonstration Board

Select Switch

Reset Switch   Power Switch
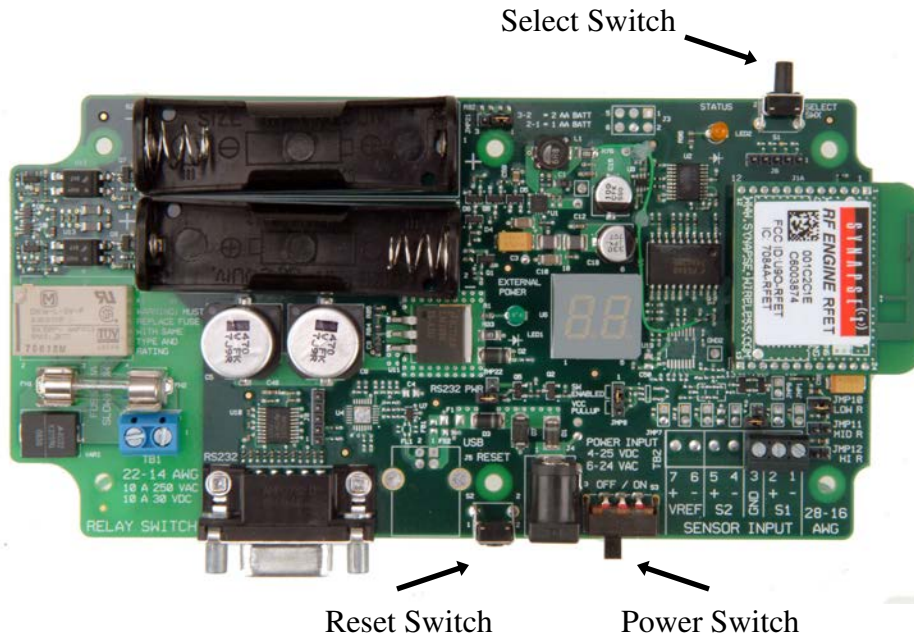
The Synapse SN111 End Device Demonstration Board features a push-button switch, LED, seven-segment display (two seven-segment digits, 14 segments total), and a generic sensor input.

The sensor input comes with a photocell pre-installed, but other analog input devices can be connected instead.

The SN111 can be powered by an external power supply (4-25 VDC, 6-24 VAC). The SN111 can also be powered by one or two AA batteries.

The SN111 does not provide ready access to all GPIO pins. Some are used by the on-board hardware, and other GPIO pins simply are not brought out to any user-accessible connector.

Since we will be talking wirelessly to this node, there is no need to connect an RS232 cable at this time. Do be aware that the RS232 port on this node is functional, and can be used to talk to other RS232 devices (including the Portal PC and even other SNAP nodes).

Refer to the "SNAP Hardware Technical Manual" for more details on this board.

Antenna Connection

At this time, you'll need to attach the supplied antenna to the SNAP Engine with the Reverse Polarity (RP) SMA type connector (shown below). SNAP Engines *without* the connector come equipped with an integrated "F" type antenna, and don't require an external antenna.
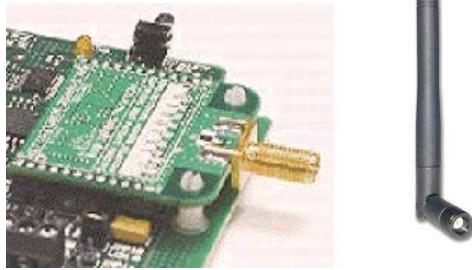
SN171 Proto Board
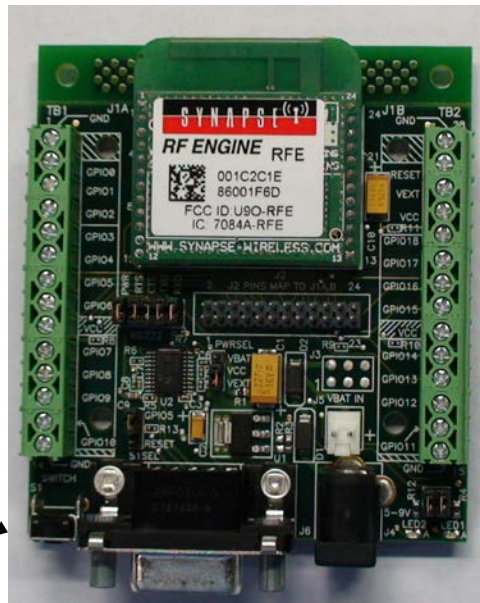
Select or Reset Switch

The Synapse SN171 Proto (prototyping) Board omits the dedicated seven-segment display and sensor input hardware of the SN111. Instead, it provides easy access to all General Purpose Input/Output (GPIO) pins, including all analog inputs. It comes with a small piezo buzzer attached to GPIO pin 9, but you can remove it if you need that pin for some other purpose.

All of the onboard SNAP Engine signals are made available at easy-access screw terminal blocks located on either side of the node. These same signals are also made available in a more compact form in the center of the board. A dual-row header provides a connection point for a ribbon-cable (or some other form of wiring harness) from some other circuit board or testing apparatus.

The SN171 can be powered by an external power supply (5-9 VDC).

The power supplies included in the EK2500 kit can be used with either of the included nodes, but be aware of the different input voltage ranges if you *substitute your own* external power supplies.

The SN171 can also be powered by two AA batteries; an external battery holder for this purpose is also included in the EK2500 kit.

The third SNAP Device in this evaluation kit is either an SN132 SNAP Stick USB Carrier Module with a SNAP Engine, or an SS200 SNAP Stick. Either of these plugs into a USB port on your PC to act as the bridge node between Portal (or SNAP Connect) and the rest of your wireless network. (For the remainder of this document, this third SNAP Device will be referred to as your "bridge device" or "bridge node".)

Taking the Nodes for a "Test Drive"

All three nodes come from the factory preloaded with a demo SNAPpy script. Although this demo script showcases only a tiny portion of the capabilities of a SNAP node, it provides a quick way to get familiar with the nodes without having to install any software on your PC. (We'll install the Portal software in a later step.)

If you haven't already done so, **power up** the bridge device by connecting it to a USB port on your PC. (If the "Found New Hardware" wizard appears, just click "Cancel" – we don't want to install that software yet).

Power up the SN111 End Device Demonstration Board by connecting it to one of the two included "wall transformer" power supplies provided in the kit, and sliding the on/off switch to the "on" position.

Power up the SN171 Proto Board node by connecting it to the other "wall transformer" power supply.

> **Note: The SN171 Proto Board does not have a dedicated on/off switch. You simply disconnect the external power supply to turn the unit "off".**

The yellow LEDs on the SN111 and SN171 boards should now be blinking once every second. This shows that the preinstalled demo SNAPpy scripts in all three nodes are running. No LED will blink on the bridge device (though a green power LED will light if you have the SN132 board).

In addition, the green "external power" LED on the larger board (the SN111 node) should be on, indicating an external power supply is connected and providing power.

On the node with the seven-segment display, "00" should be displayed. This shows that the pre-loaded SNAPpy script is running. (It put the "00" pattern on the display.)

If all of your nodes are on and the yellow LEDs are blinking, proceed to the next section. Otherwise, here are some trouble-shooting tips that may apply.

<div style="border:1px solid black; padding:1em;">

<u>SN111 Troubleshooting</u>

Tip: "Lit" does not always mean "on"
On the SN111 node, the "external power" LED indicates just that – that external power is currently being provided to the board – but it (by itself) does not indicate that the SNAP Engine has actually been powered. You must manually slide the on/off switch (located next to the "barrel" power connectors) to the "on" position.

</div>

<div style="border:1px solid black; padding:1em;">
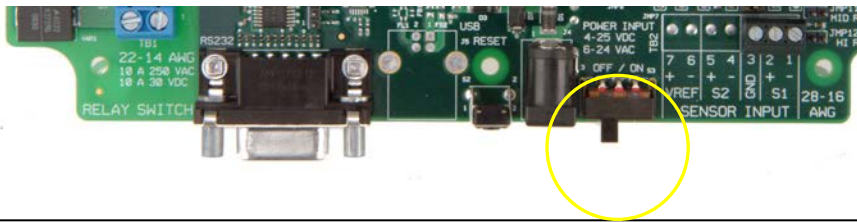
<u>SN171 Proto Board Troubleshooting</u>

Tip #1: Verify the power-related jumpers:
Your SN171 "proto-board" node should have come from the factory preconfigured to work with an external DC power supply. Still, as a double-check, verify that the PWRSEL jumper is in the VEXT position (connecting pins 2-3), not the VBAT position (connecting pins 1-2).

Tip #2: Verify the LED related jumpers:
The SN171 "proto-board" node should come from the factory preconfigured to enable its two on-board LEDs (one yellow, one green). If the unit is not blinking its yellow LED, it is worth verifying that the LED1 and LED2 jumpers are both installed.

</div>
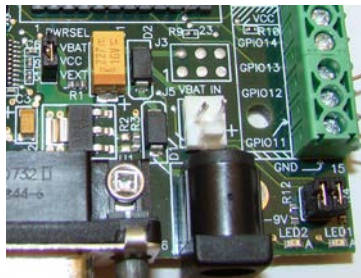
Time to push some buttons! (Seeing the demo script in action)

Using our "multicast" capability, here we use the preloaded SNAPpy script "McastCounter.py" to show that all three nodes can talk to (and hear) each other.

Press the select switch on the SN111 End Device Demonstration Board or the SN171 Proto Board. The seven-segment display on the SN111 should now be showing "01." *The SN171 Proto Board and the bridge device receive the count as well, but have no seven-segment display to display the change. Instead you can watch the lower two bits of the count displayed on LED2 and LED1 on the SN171, and as a cycling tri-color LED on the SNAP Stick.*

Each additional button press should advance the displayed count by one (wrapping around to 00 after the maximum value of 99), *regardless of which node's button you use*.

Press the button on the SN171 Proto Board node to see it advance the count as well. (If this does not function as expected, check the S1SEL jumper on the SN171 to be sure it is connecting the GPIO5 pin rather than the RESET pin.) **Turn off** the SN111 End Device board, and then turn it back **on.** Notice that it is now displaying 00 on its seven-segment display. **Press** the button on the SN171, and the SN111 will now display the new count.

Press and hold for two seconds the push-button on either of the nodes to **reset the count** to zero. The node with the seven-segment display should now show "00".

Unplug the SNAP Stick from the USB port. **Press** the buttons on the remaining nodes. The displayed count on the remaining nodes should still increment with every press of the Select button.

*The "bridge" node can provide the eventual connection to the Portal PC, but it is **not** a "coordinator" of the SNAP network. (there is no central coordinator with SNAP)*

Plug the SNAP Stick back in if you want to see all three nodes interoperating some more.

Some things to notice:

The nodes are immediately able to communicate with each other:
       There is no such thing as a "network join time" with SNAP.

Any node can talk directly to any other node:
       There is no central "coordinator" node with SNAP.

Using SNAPpy scripts, SNAP nodes can autonomously respond to changes in their environment:

Here you have a user pushing a button, but it could be any digital input, for example, "water detected", or even an analog input such as "furnace temperature."

Turn off the nodes when you are ready to begin installing the Portal software.

More about the Hardware

Since the Portal PC (the PC that the Portal software will be running on) has no radio of its own, one of the SNAP nodes must act as a "bridge" for it. Portal will connect *directly* to this bridge node, using either a USB or RS232 connection. Portal will then be able to communicate to the rest of the SNAP nodes *indirectly*, by sending packets *across* the directly connected bridge node.

Verify that the SNAP Stick is correctly connected to the PC's USB port.

Device Configurations

The following table assumes you have not moved any of your RF Engines between the different boards and does not apply to kits with the **RF300**.

Synapse Network Evaluation Kit RF Engine Configurations:

Description	Function	Antenna	Power Amp	Receive Amp
SN200 SNAP Stick	Portal interface	Integrated	Yes	Yes
SN111 End Device Demonstration Board	Photocell	External	Yes	Yes
SN171 Proto Board	Buzzer	Integrated	Yes	Yes

It is also important to understand that SNAP Engines are not fixed to the boards on which they're provided in the EK2500 kit. You can move the engines between boards, if you desire. For example, the SN171 Proto Board can be used with an RFET SNAP Engine that has an external antenna.
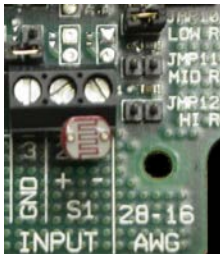
A *Photocell* component is connected to Sensor Input terminals 1&2 on the **End Device**. Note that the pullup-resistor strap is in the *LOW* range position, with jumper J10 jumped, to properly condition this sensor type.

3.   Installing Portal

The Synapse Network Evaluation Kit contains a sheet of paper with instructions for where to download the Portal Installer and SNAP support documentation. This provides all the software you need to get started with SNAP and Portal. Additional updates, and the most current release of this software will always be available on the Synapse support forum.

Updates on the Web

You'll find the latest version of Portal on the Synapse Support Forum at http://forums.synapse-wireless.com (look under Software Releases -> latest Releases).

Portal comes bundled with the latest SNAP firmware and documentation.

Also be sure to check the Synapse website at http://www.synapse-wireless.com

Running Setup

Download and run the Portal installer, Portal-setup-2.4.n.exe (where "n" indicates the latest release version).

Depending on the version of Windows running on your PC, you may get a warning dialog similar to the following somewhere in the installation process:

The warning is harmless, and you should click on **Run** or **Continue Anyway** to proceed with the installation.

NOTE – if a previous version of Portal (for example, version 2.2.23) is already installed on your computer, you will get an initial dialog box like the following:
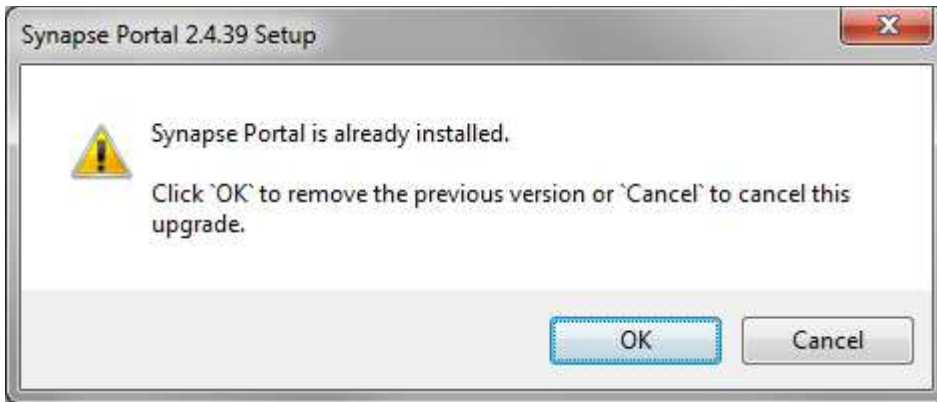
You must click the "OK" button in order to install the newer version.

If you are using an operating system other than Windows, follow the installation directions that are provided with your OS's installer. For the Linux installation, be sure to consult the readme file that is included with the .deb package file.

The following screenshots assume you are installing in Windows. Your precise Portal version number might be different from 2.2.39, but the process should be very similar.
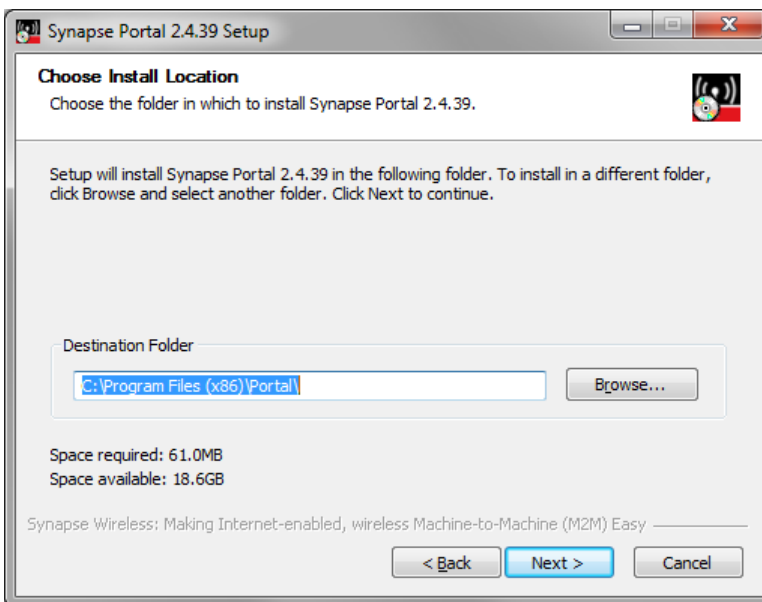
A dialog box similar to the following will appear (your version number will be higher).
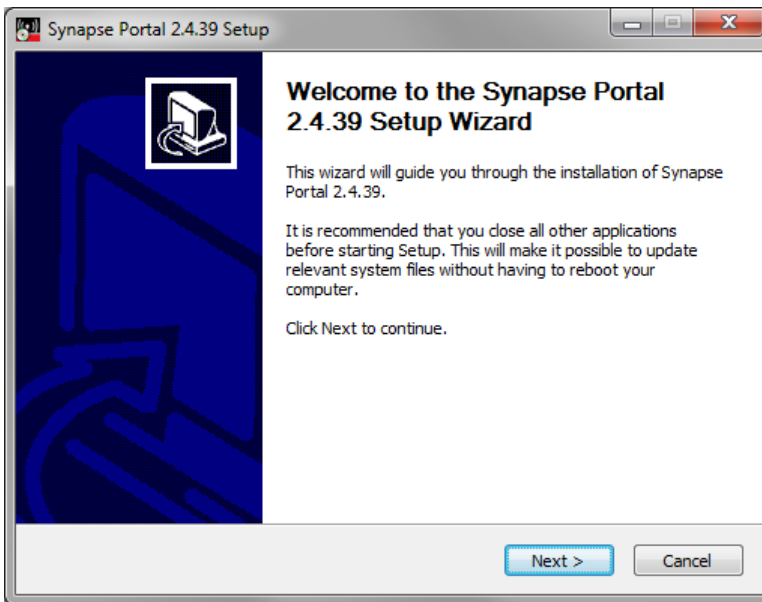
Click the **Next** button to get the following:
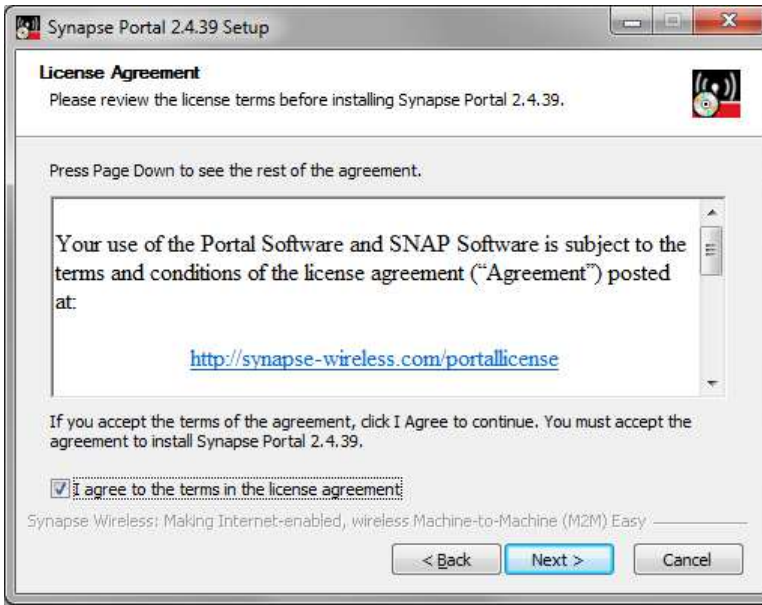
Read the license agreement at the specified URL, check the "*I agree*" box and then click on **Next**.

You can either enter the desired destination folder manually, browse to the desired folder, or just click on **Next** to accept the default.
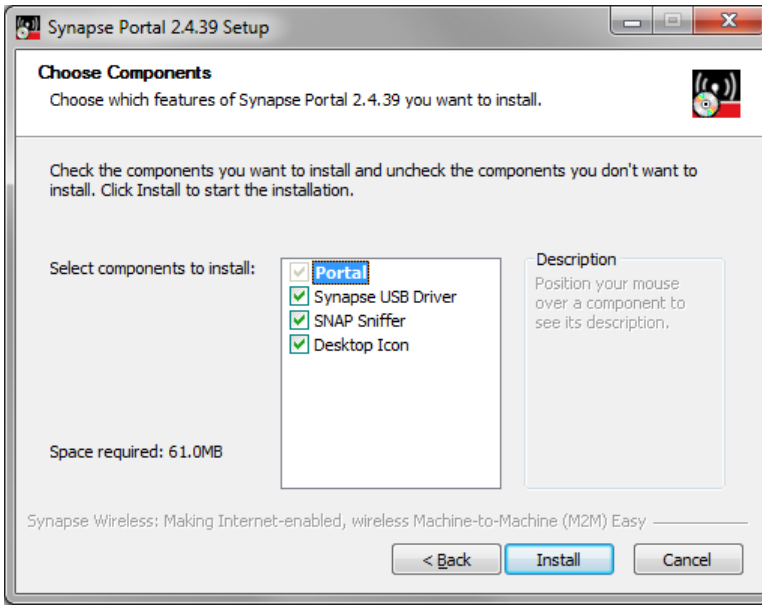
Make sure the desired components are checked, and click on **Install**.

After several files have been processed, if you specified that USB drivers should be installed you will get the following dialog box:

To ensure that the latest Synapse USB drivers can be installed, you must not be running the old versions of these drivers. Disconnect any Synapse USB devices to ensure this, and then click on the "OK" button. The installation process will continue.
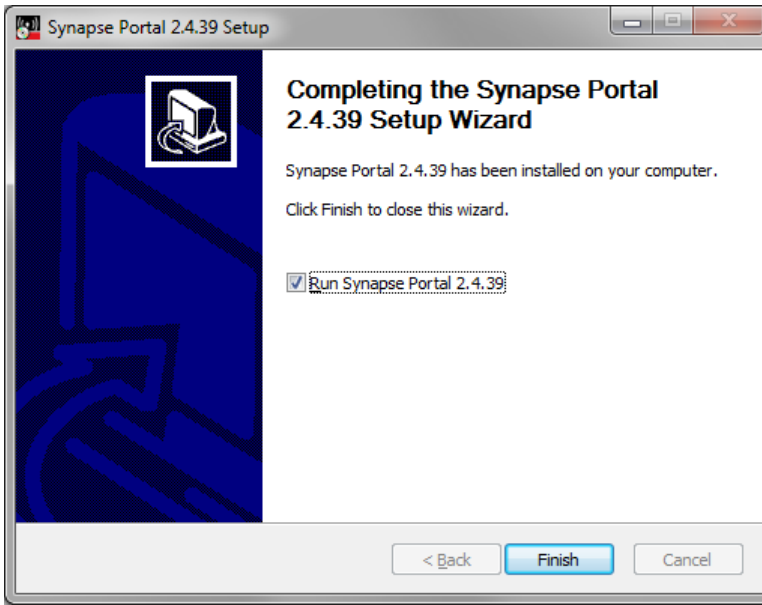
You have now successfully installed *Portal*. There will be a *Portal* icon on your Windows *Desktop* (if you specified there should be), as well as in the *Start Menu*. We recommend that you do *not* run *Portal* until you have completed the bridge device driver installation through the following steps, so you should uncheck the "Run Synapse Portal" checkbox before clicking "Finish".

Plug in the Bridge Device

The SNAP Stick bridge device should now be plugged into a USB port on the PC on which you installed Portal. Depending on the drivers loaded on your system and which version of Windows you are using, it may be necessary for the Synapse USB drivers to complete installation. This will only occur the first time the bridge device is connected and powered up. If necessary, the following dialog box will appear:
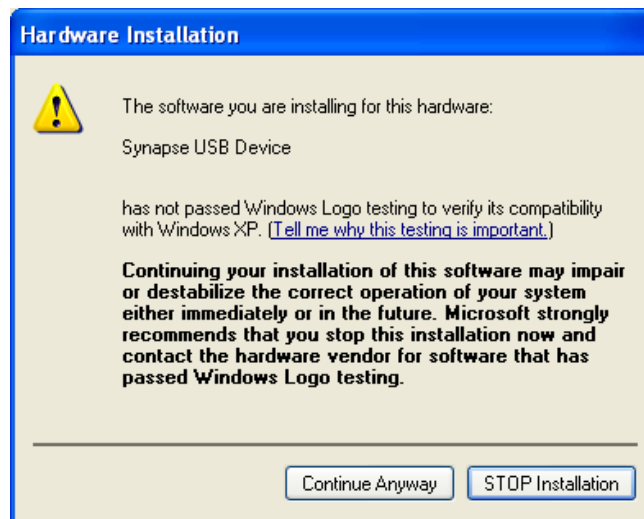
Since the correct software is already available (you just installed it along with Portal), there is no need for Windows to connect to Windows Update – just select "**No, not this time**" and then click on **Next**.
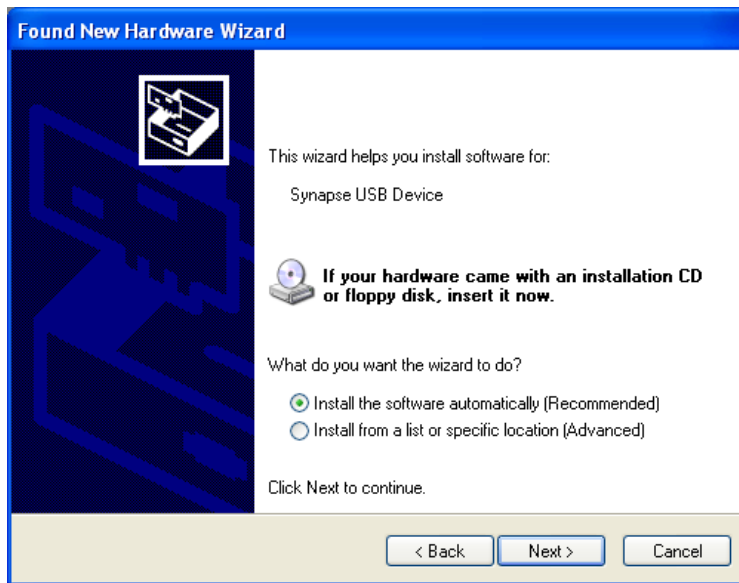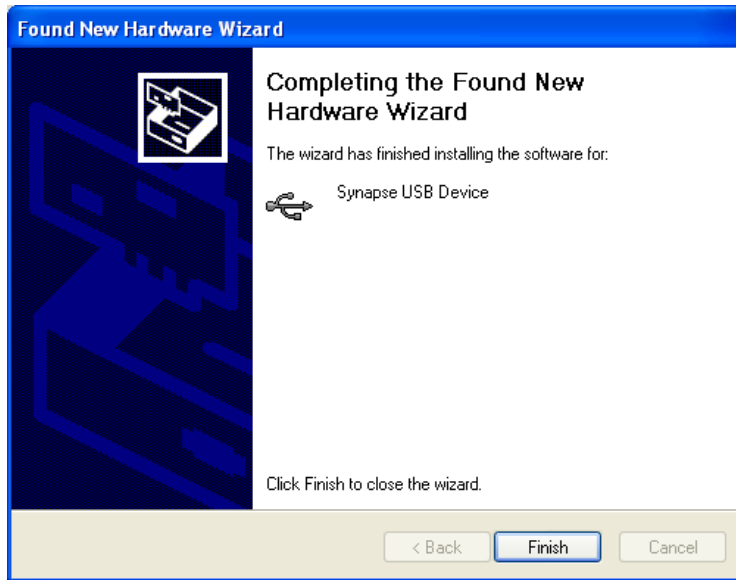

Choose "**Install the software automatically**…" and click on **Next**.

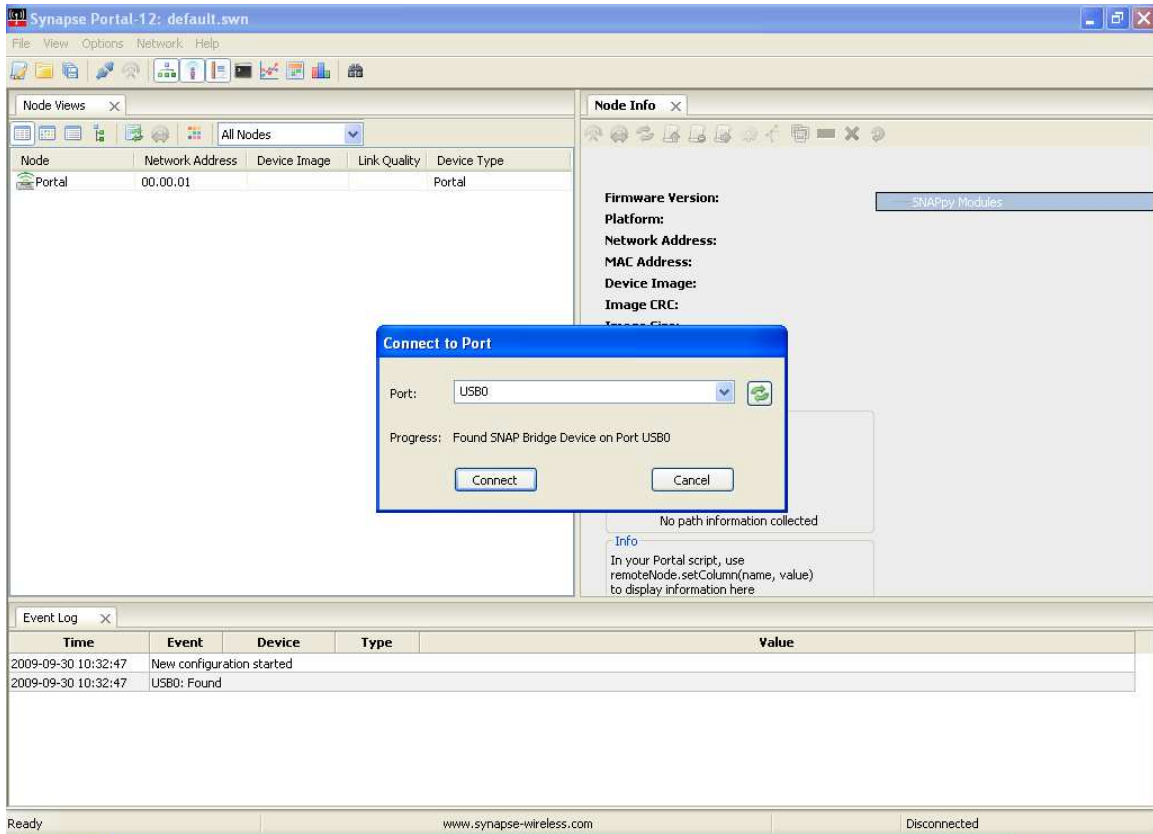Depending on the version of Windows you are running, you may get a warning dialog similar to the following:

This warning is harmless, and you should click on **Continue Anyway**.

Congratulations! Your *Synapse USB Device* is installed and ready to be used by Portal.

Launch

After installation, launch the **Portal** program. You should see a screen similar to the following:

You have now successfully installed Portal, and detected a USB-connected bridge device.

Note – The "Connect" dialog box is automatically shown at Portal startup. If you click the **Cancel** button, you can *bring this dialog back* by clicking the ![icon] button on the main toolbar.

Also be aware that this toolbar button doubles as a status indicator. When you *are* connected, it looks like ![icon], and functions as a *disconnect* button. When you *are not* connected, it looks like ![icon] and functions as a *connect* button.