DaintreeNetworks

"Active" analysis and configuration using the Daintree Networks Sensor Network Analyzer

Application Note AN024

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Sensor Network Analyzer Release 2.2 (2008-05-09)

About "active" analysis and configuration

"Active" analysis and configuration refers to a set of features available when using Daintree's Sensor Network Analyzer (SNA) software with an active-enabled hardware device.

Active devices are able to join an 802.15.4 or ZigBee network, interact with other devices on it, actively poll devices to gain information not available through passive "sniffing" alone, and send and receive ZigBee standard and proprietary messages.

Devices that provide active support include the following:

- Daintree Networks 2400E Sensor Network Adapter
- Integration Associates ZigBee USB Dongle
- Ember EM250 Breakout Board together with EM250 RCM

About Daintree's Sensor Network Analyzer (SNA)

The SNA combines a powerful protocol analyzer with network visualization, measurements and diagnostics for IEEE 802.15.4™ and ZigBee® applications. It provides automatic display of network formation, topology changes, and router and coordinator state changes allowing rapid detection of incorrect network behavior and identification of device or network failures.

It also provides a powerful commissioning tool that helps to hide the complexity of the underlying technology, and provides straight-forward configuration, testing and troubleshooting capabilities. Its graphical representations makes if fast and easy for installers to monitor network formation and measure key parameters such as link quality and bindings.

About the 2400E Sensor Network Adapter

As mentioned above, Daintree's 2400E Sensor Network Adapter can be used with the SNA software as an active device.

Visit www.daintree.net to find out more about Daintree products.

Active analysis and configuration tasks

When using an active device with the SNA software, the following features are available:

Analysis and discovery

- Active channel scan: Send beacon requests on each channel and monitor the responses to determine which channels contain 802.15.4 networks and what the ambient energy (in dBm) is for each channel.
- Join: Join the active device to an existing network.
- Discover network structure: Discover the structure of a network, and then update the Visual Device windows to show the discovered network topology.
- Request power/battery levels: Poll devices for their current power source (including battery level if applicable)
- Request neighbor LQI: Poll devices to determine their current LQI (Link Quality Indicator)
- Locationing: Discover the location of a device whose where-abouts is unknown or subject to change.**

Commissioning and configuration

- Start network: Start a new network with either the active device, or any other device, as coordinator.
- Commission: Configure device setup attributes, including setting channel masks, EPIDs, and network keys.
- Binding: Perform service discovery and then create individual or group bindings.
- Leave: Force a specific device to leave the network.
- Permit join: Allow or stop devices from joining a specific device or the entire network.
- Over the air (OTA) firmware upgrades: Upgrade the firmware on devices that are already deployed.**
- API: Send and receive commands over-the-air using the SNA's Application Program Interface (API).

** Supported on selected stacks only.

Note that the following pages describe these tasks at a fairly high level, and are intended to provide an overview of the functionality that active devices can provide. Please refer to the SNA's online help if you require additional information.

This application note describes features available in the Professional edition of the Sensor Network Analyzer. In a multi-node scenario, only the first device specified in the multi-node group is available as the active device.

Analysis and discovery tasks

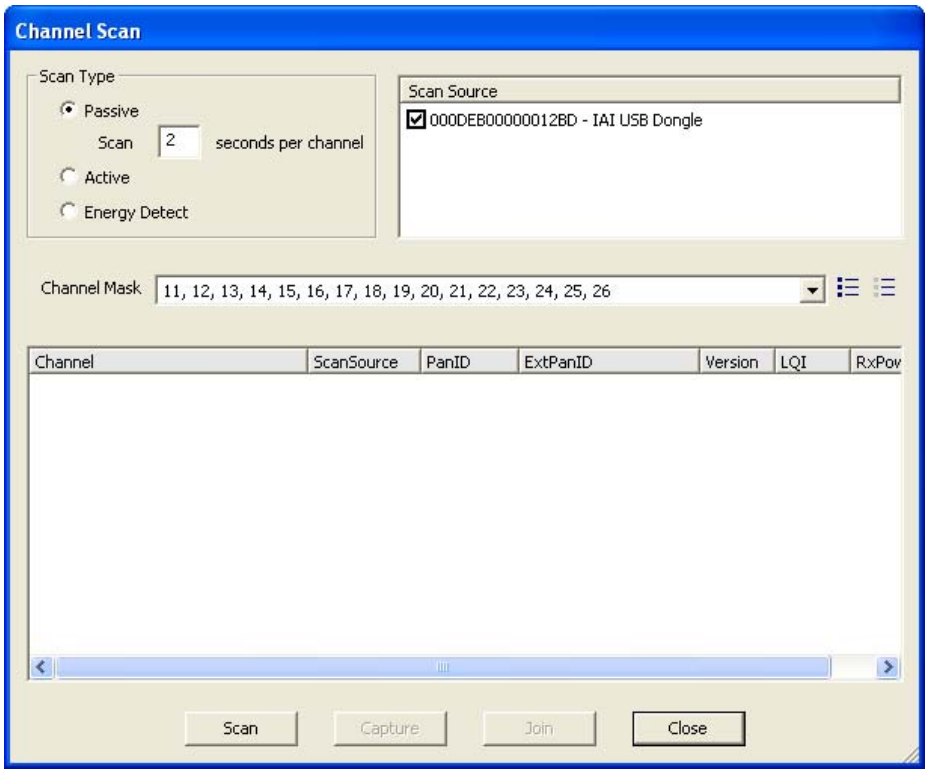
These tasks provide you with information about live networks and devices. They are particularly useful during testing, field trials, and network management to obtain an overview of what is happening on the network.

Active channel scan

The active device sends three beacon requests on each selected channel and waits for a response from one or more devices. Each device that responds to the beacon request is listed in the Channel Scan dialog box, with details including PAN ID, Short Address on that PAN, the detected LQI of the Beacon response, and whether or not the Beacon Payload indicates that the device is Accepting Associations.

You can also perform an energy scan, which shows the ambient energy level (in dBm) detected on each channel. Channels with lower energy levels are more suitable for starting a new network, indicating low levels of interference and the unlikely presence of other networks.

1. Open the Channel scan dialog box in one of the following ways:
   - On a Visual Device window, right-click an active device, and then select **Active Device > Channel Scan**.
   - On the Device Manager Commission or Capture tab, select an active device, and then click  .
   - On the main SNA toolbar, select a **Source**, and then click  .



2. Select to perform either an **Active** or **Energy Detect** scan.
3. Select the source and channels on which to perform the scan, and then click **Scan**. Once clicked, this button is disabled until the scan completes.

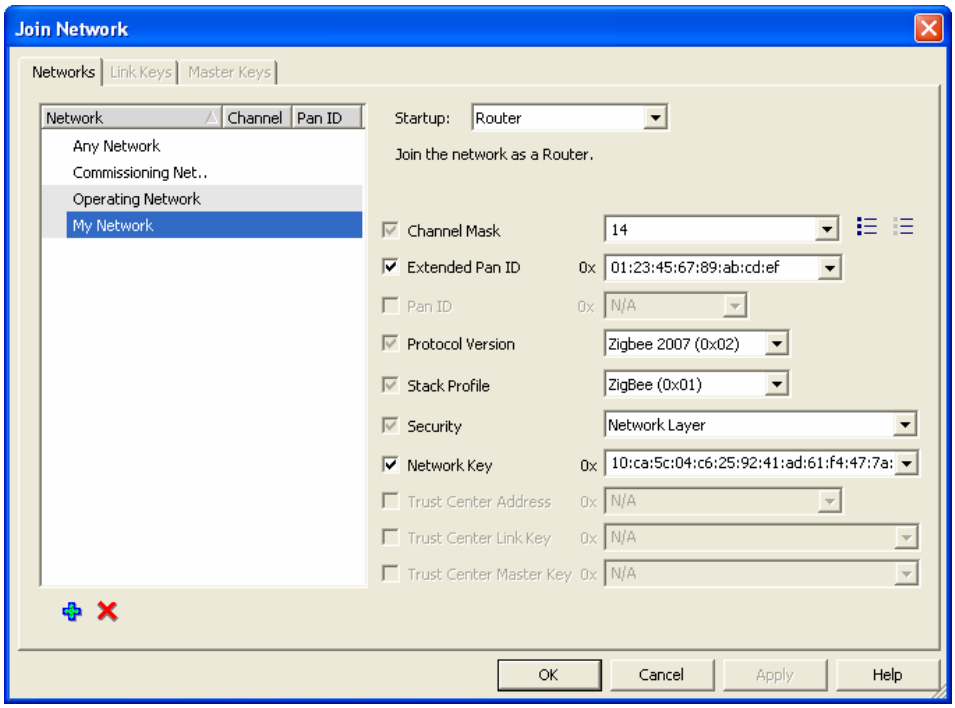
   When the scan is complete, all devices found are shown in the table at the bottom of the Channel Scan dialog box.
4. Click a device in the table to select it. You can now click the **Capture** button to start a capture on the detected. For active devices, you can also click the **Join** button to join the selected device (or network).

   Note that the Join option is available only if the selected device or network is accepting associations.

Join network

Use this option to join an existing network. If you want to use the active device to start a new network, see Start network.

1. Open the Join Network dialog box in one of the following ways:
   - Right-click an active device in a Visual Device window, and then select **Active Device > Join Network**.
   - On the Device Manager Commission tab, select an active device, and then click  .
   - On the Device Manager Commission tab, right-click an active device, and then select **Join Network**.



2. Select a Network from the list, or click  and type a name to create a new network description.

3. Select to join the network as either a **Router** or **End Device**.
4. Type or select the settings for the network you want to join, and then click **OK**. The Device Manager and Visual Device windows will update to show you when the device successfully joins the network.

   When selecting a channel mask, you can click  to select all channels, or  to clear all channels.

Discover network structure

The Discover Network operation dynamically discovers the topology of an existing network and updates the SNA's Visual Device windows. Without active analysis, the SNA needs to observe the original network formation to display all devices.

After Joining a network, you can discover its structure in one of the following ways:

- On a Visual Device window, right-click an active device, and then select **Active Device > Discover Network**.
- On the Device Manager Commission tab, select an active device, and then click  .
- On the Device Manager Commission tab, right-click an active device, and then select **Discover Network**.

During the network discovery, the SNA does the following:

- Clears the list of devices on the current channel and PAN.
- Clears the Visual Device windows.
- Sends requests (through the active device) into the network to dynamically discover the network topology.
- As devices are detected, updates the Visual Device and Measurements windows.
- Updates the Packet List and Timeline windows to show the sequence of packets transmitted and received.
- Updates the Device Manager Summary and Commission tabs to show all devices.

Update power/battery level details

You can choose to show power/battery level information on the Visual Device windows by selecting a **View** type of **Battery Levels**, or by selecting to **Define** a view that includes **Battery Levels**. (See the SNA online help for instructions.)

After Joining a network, you can update power levels in the following ways:

- To update power levels for all devices: In the Visual Device window, right-click an active device, and then select **Active Device** > **Update Power Levels on All Devices**.
- To update power levels for an individual device: In the Visual Device window, right-click the device, and then select **Active Device** > **Update Power Levels**.

This causes the active device to send a PowerDescReq message to each node in the network, and then process the corresponding PowerDescRsp messages it receives in return. The power source

(mains v battery) and battery level (if applicable) are then extracted and made available for display on the Visual Device windows.

Update neighbor LQI details

You can choose to show Link Quality Indicator (LQI) information on the Visual Device windows by selecting a **View** type of **Inter-device LQI**, or by selecting to **Define** a view that includes **Inter-device LQI**. (See the SNA online help for instructions.)

After Joining a network, you can update neighbor LQI details in the following ways:

- To update LQI details for all devices: In the Visual Device window, right-click an active device, and then select **Active Device** > **Update Neighbor LQI Values on All Devices**.
- To update LQI details for an individual device: In the Visual Device window, right-click the device, and then select **Active Device** > **Update Neighbor LQI Values**.

This causes the active device to send a MgmtLqiReq message to each node in the network, and then process the corresponding MgmtLqiRsp messages it receives in return. The LQI values are then extracted and made available for display on the Visual Device windows.

Locationing

Locationing allows you to discover the position of devices whose where-abouts is unknown or subject to change. This functionality is useful for troubleshooting (to help you quickly locate a device of interest), and also within deployed networks to help to keep track of mobile devices

The SNA currently provides locationing support for TI's CC2431 location engine.

Refer to the Daintree Networks Application Note **AN016 Locating ZigBee nodes using TI's CC2431 location engine and Daintree's SNA** for detailed instructions explaining how this feature works. (Application notes are available from Daintree's web site at http://www.daintree.net/support/appnotes.php.)

Commissioning and configuration

Commissioning is the physical deployment, addressing, and logical binding of nodes to form a functional network. You commission all types of networks, including those used for testing and field trials, and live deployed networks.

Start network

You can start a network using an active device as its coordinator. One common reason to perform this task is to create a "commissioning network", through which you can configure and commission devices before adding them to live networks.

Refer to the Daintree Networks Application Note **AN023 Start-up commissioning and binding using Daintree's SNA** for detailed instructions explaining how this feature works. (Application notes are available from Daintree's web site at http://www.daintree.net/support/appnotes.php.)

Commission devices

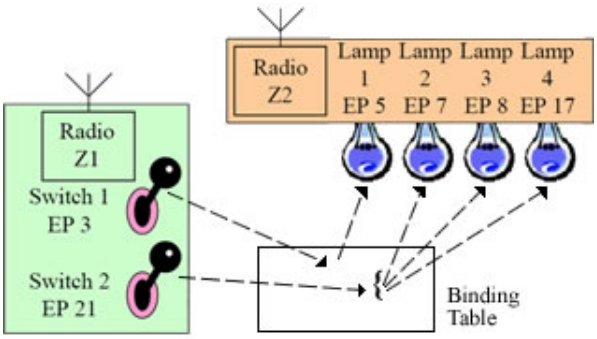
After starting or joining a network with your active device, you can configure and commission the other devices on that network. Part of this configuration can be to move devices from your "commissioning network" to a live (field trial or deployment) network.

Commissioning allows you to specify all required addressing, protocol, security and other parameters.

Refer to the Daintree Networks Application Note **AN023 Start-up commissioning and binding using Daintree's SNA** for detailed instructions explaining how this feature works. (Application notes are available from Daintree's web site at http://www.daintree.net/support/appnotes.php.)

Create bindings and groups

Bindings are connections between end devices in a ZigBee network, such as a connection between a light switch and the light that it operates. Each binding supports a specific Application Profile, and each message type is represented by a Cluster (within that profile).



You can create bindings between endpoints that use the same Application Profile and that have associated Output/Input Clusters (for example, one with an On/off Output Cluster, and another one with an On/off Input Cluster).

In addition to binding individual endpoints, you can also group together a number of endpoints and bind them as a single entity. For example, you may want to use a single endpoint to control all lights in a conference room or all heating units on a single floor.

Refer to the Daintree Networks Application Note **AN019 Binding and group commissioning using Daintree's SNA** for detailed instructions explaining how this feature works. (Application notes are available from Daintree's web site at http://www.daintree.net/support/appnotes.php.)

Leave network

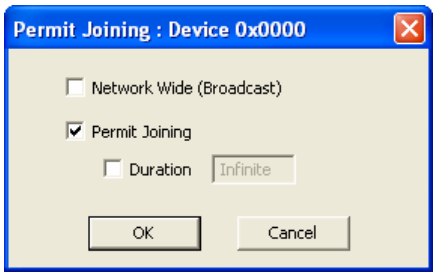
Leave the network in one of the following ways:

- Right-click a device in a Visual Device window, and then select **Active Device** > **Leave Network**.
- On the Device Manager Commission tab, select a device, and then click .
- On the Device Manager Commission tab, right-click a device, and then select **Leave Network**.

Permit Join

After Joining or Starting a network, you can use permit joining to either allow or stop devices from joining a specific device or your entire network.

1. Open the Permit Join dialog box in one of the following ways:
   - Right-click a device in a Visual Device window, and then select **Active Device** > **Permit Join**.
   - On the Device Manager Commission tab, select a device, and then click .
   - On the Device Manager Commission tab, right-click a device, and then select **Permit Join**.



2. Select or deselect **Permit Joining** to turn it on or off. You can also specify a time **Duration** if required. (If no duration is specified, the duration is infinite.)
3. Select **Network Wide (Broadcast)** to turn Permit Join on/off for the entire network. Deselect this value to turn Permit Join on/off for the selected device.
4. Click **OK**.

When you turn Permit Joining off, no new devices can join the specified device or network. All devices that are currently joined will remain so.

Over the air (OTA) firmware upgrades

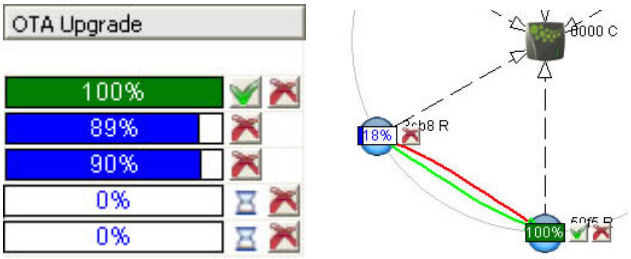
There are many times at which you may need to upgrade the code (firmware) stored on a device, for example, to fix bugs during development and field trials, or to add new functionality either during commissioning or in an already deployed network.

One way to do this is to physically connect each device via cable to a computer or PDA, and then download the code to each device in turn. This laborious and time-consuming process is prone to errors (such as some nodes being forgotten or not correctly updated), and can become completely unworkable in larger networks.

OTA upgrades, which as the name implies performs the upgrade over-the-air using ZigBee/802.15.4 connectivity, provides a faster, easier and more accurate way to upgrade firmware.

The SNA currently provides OTA upgrades support for TI's CC2430 and CC2431 SoC solutions.

Refer to the Daintree Networks Application Note **AN017 Upgrading firmware over-the-air using TI's SoC and Daintree's SNA** for detailed instructions explaining how this feature works. (Application notes are available from Daintree's web site at http://www.daintree.net/support/appnotes.php.)



Use the SNA's API

The SNA provides an XML-based string over TCP/IP socket API (Application Program Interface) to send and receive commands over-the-air using an active device.

The API has been created specifically to help with the testing and validation of ZigBee application profiles.

In ZigBee, application profiles describe a collection of devices employed for a specific application, and implicitly, the messaging scheme between those devices. For example, there are application profiles defined for home automation systems and commercial, industrial and institutional systems.

The SNA's API can be used for the testing and validation of both public (defined by the ZigBee Alliance) and private (manufacturer-specific or proprietary) application profiles.

Contact Daintree (at sales@daintree.net) to find out how to get a copy of the Application Note **AN021 Testing and validating ZigBee application profiles using Daintree's SNA**, which provides detailed instructions explaining how this feature works.