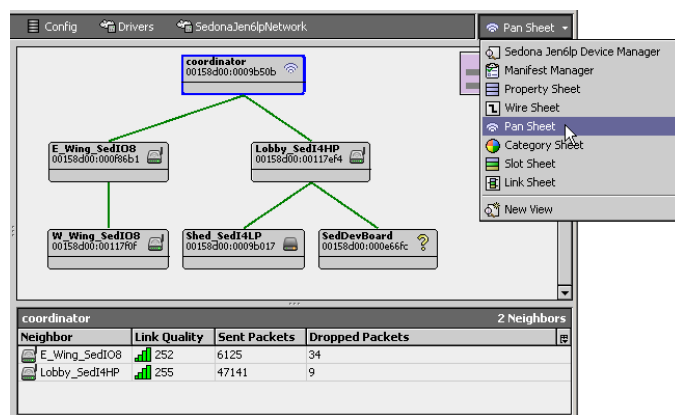# Jennic Network Visualization (Pan Sheet)

Note: *If using NiagaraAX-3.8, and planning to install Sedona Framework TXS, you must use an "update 1" bundle of TXS-1.2: version 1.2.1xx (for example 1.2.100). Whereas if using AX-3.7/AX-3.7u1, you use an earlier TXS-1.2 bundle: version 1.2.2x (for example 1.2.28.4). And in the case of AX-3.7u1 (3.7.106 or later), after installing the 1.2.28.4 bundle you need to download and install a patched* nsedona *module, version 1.2.28.1.*

For more details, see the latest (February 2014 or later) revision of the NiagaraAX Sedona Framework TXS-1.2 Installer Guide*.*

This document is about the "PAN Info" mechanism in a **SedonaJen6lpNetwork** in a NiagaraAX station running on a JACE controller that is equipped with a Sedona Jennic option card. This network type is used to model 802.15.4 wireless (Jennic-based) Sedona Framework devices in the station.

Figure 1 *Pan Sheet view on the SedonaJen6lpNetwork provides network visualization*

As shown in Figure 1, a "**Pan Sheet**" view on the network provides a *graphic visualization* of the underlying "JenNet" self-healing tree structure, along with RF signal strength data of devices. This view uses data collected in "PAN info polling" (or "Load Pan Info" actions) of devices on the network. The Pan Sheet is a *diagnostic tool* for examining the wireless network, and identifying RF signal strength problems.

Note: *During normal operation with a stable installed system, enabling PAN info polling is not recommended, as it adds to overall network messaging traffic. However, when first installing a network of Jennic-based devices, or if (and when) subsequent communications issues arise, loading PAN info can be a valuable aid.*

The following sections are included in this document:

Requirements for Pan Sheet

Usage of PAN info first requires the SedonaJen6lpNetwork to be added in the station, with Jennic-devices discovered and added to the network. For related details, see "Configure a SedonaJen6lpNetwork" in the *NiagaraAX Sedona Networks Guide*.

For each device, you must know if it is "router capable" or an "end device" (non-routing capable) in its Jennic capacity. Many (if not most) non-hibernating devices operate as routers.

Each router-capable Jennic device requires the following:

- The `paninfo` kit installed.
- If Chopan (vs. Sox) is to be used for PAN info polling, devices also need the `chopan` and `paninfo-Chopan` kits installed.
  Note: *Chopan uses less message overhead than Sox, and is the default method for the Paninfo Poller in a SedonaJen6lpNetwork. However, it requires devices to have these two additional kits installed. If PAN info polling via Chopan, devices without these kits will remain in "fault", with link status "N/A".*

PAN Info Quick Steps

To get started with PAN info and the Pan Sheet view, perform the following:

- Configure router-capable Jennic-based devices for PAN info. (Router-capable devices only)
- Configure modeled SedonaJen6lpDevices in station. (Do this for all devices)
- Configure SedonaJen6lpNetwork in station.

Configure router-capable Jennic-based devices for PAN info

Using NiagaraAX Workbench, do this for each *router-capable* device in the **SedonaJen6lpNetwork**: (non-router devices do not require this configuration)

Step 1   Open a tunneled 🔧 Sox connection to the device.

Step 2   Verify it has the `paninfo` kit installed.

If using Chopan for PAN info polling, verify it *also* has the kits `chopan` *and* `paninfoChopan` installed.

If needed, install one or more kits above into the device using the **Kit Manager**. When done, reopen a Sox connection to the device.

Step 3   Open the device's Sedona Framework 📋 **App** node, and expand the service container.

Step 4   Open the 🟥 **Sedona Palette** in the Workbench sidebar, and choose the 🗋 `paninfo` palette.

Step 5   Add the ⚫ **PanInfoService** to the `service` container of the app (if not already present). By default, the component's name is trimmed to "PanInfo".

If using Sox for PAN info polling, this is all the configuration required. Go to Step 7.

Step 6   If using Chopan for PAN info polling:

1. Verify the app has the ⚫ **ChopanS** (ChopanService), typically found in its service container.
   If missing, open the 🗋 `chopan` palette and *add* the ChopanService to the service container.

2. Open the 🗋 `paninfoChopan` palette. If if not already present, *add* the ⚪ **PanInfoServlet** under the app's ⚫ **ChopanS** (ChopanService), as the recommended place. By default, this component's name is trimmed to "PanSvlt".

Step 7   Save the app (right-click 📋 **App** node and select **Actions > Save**).

Configure modeled SedonaJen6lpDevices in station

Perform this for *every* **SedonaJen6lpDevice** in the JACE station's SedonaJen6lpNetwork:

Step 1   Expand the 🔲 **SedonaJen6lpNetwork** to reveal child 🔳 devices.

Step 2   Double-click a device to open its **Property Sheet** view.

Step 3   Near the property sheet *bottom*, find the **Device Type** property, and set from "Unknown" to either:

- Router — Device is capable of Jennic router operation.
- End Device — Device cannot provide Jennic router operation (typical to a device that *hibernates*).

Many other device properties are related to PAN info operation, but do not need initial configuration. For related details, see "PAN info data" on page 6.

Step 4   Save the property sheet configuration (click **Save** button).

Configure SedonaJen6lpNetwork in station

Step 1   Open the *property sheet* for the 🔲 **SedonaJen6lpNetwork**.

Step 2   Scroll down and expand the 🔲 **PanInfo Poller** container. Set child properties as follows:

- **Use Chopan**
  If true (default), Chopan is used for PAN info polling instead of Sox.
  Set to false (for Sox polling) if devices are not configured for Chopan PAN info polling.
  (For related details, see "Configure router-capable Jennic-based devices for PAN info" on page 2.)
- **Enabled**
  Enables PAN info polling. *After setting* "Use Chopan" (first property), set to true. Note that right-click actions **Enable** and **Disable** on the **PanInfo Poller** also write to this property.
  Note: *When done using the Pan Sheet, disable (set to false) for normal system operation.*
- **Desired Poll Period**
  Default is 5 minutes. Specifies the target "internode delay" between periodic PAN info polling. Setting less than 1 minute is not recommended.

Step 3   Save the property sheet configuration (click **Save** button).

Note: *As an alternative to periodic PAN info polling, you can do "on demand" PAN info polling. This even works if leaving the Enabled property of the PanInfo Poller at* false. *In this case:*

1. Right-click the **SedonaJen6lpNetwork** and select **Actions > Delete All Pan Info**.
2. Right-click the **SedonaJen6lpNetwork** and select **Actions > Load All Pan Info**.
3. Wait some amount of time, for example for a 25 node network, between 1-1/2 to 2 minutes. This allows for the time necessary to consecutively retrieve data from the Jennic-based devices.
4. View the Pan Sheet (right-click the **SedonaJen6lpNetwork** and select **Views > Pan Sheet**).

Many other network properties are related to PAN info operation, but do not need initial configuration. For related details, see "PAN info data" on page 6.

Step 4   View and analyze data on the network's Pan Sheet view. See "Using the Pan Sheet" on page 3. For background details, see "PAN Info background" on page 5.

Using the Pan Sheet

When you access the Pan Sheet view (right-click the network and select **Views > Pan Sheet**), this builds a graphical representation of the current JenNet tree, using available "PAN info" in the station.

Figure 2   *Accessing Pan Sheet view (under construction)*
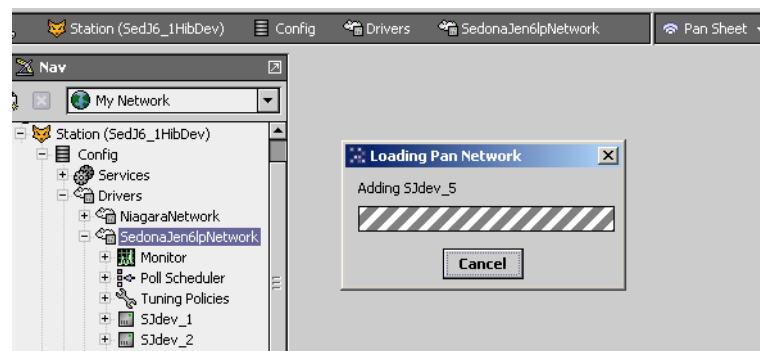
If for some reason station PAN info is missing about the coordinator and/or one or more known router devices, it is automatically retrieved again when building this view, as shown in the Figure 2 popup above.

When the view is built, it is split into two panes, top and bottom, as shown in Figure 3. If necessary, click and drag the separator bar between the two panes to resize.

Figure 3   *Two panes in Pan Sheet view*
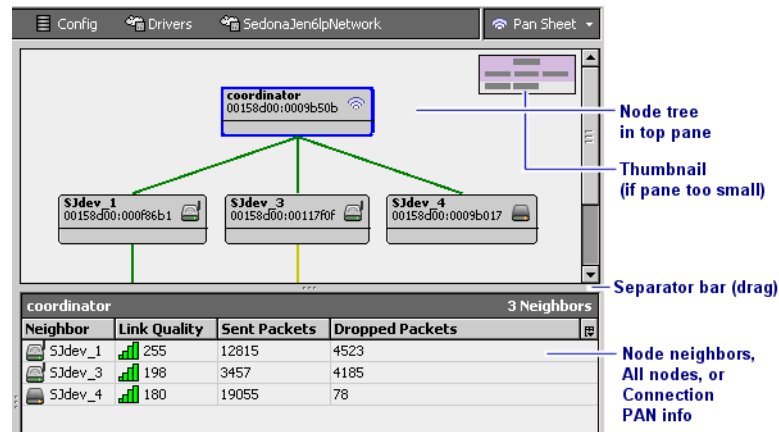
- *Top pane* shows the current node tree architecture, with coordinator node (JACE with Sedona Jennic option card) at the top. In the upper right corner, a node tree "thumbnail" appears if a large network, or if the pane is sized small. Click inside the thumbnail to steer the top pane to that area.
    - Click a node in the tree to select it (blue outline around node), or click the background to deselect all nodes for a "Pan Network". (Initially the view has the coordinator node selected).
    - Click any connection line between two nodes to select it.
    Note: Different selections change the contents of the table in the bottom pane, see below.
- *Bottom pane* reflects PAN info relative to selection (node, connection, or all nodes, "Pan Network"). Such data includes Link Quality (LQI number), Sent Packets and Dropped Packets.
    - For any one *selected node* in the top pane, the table shows PAN info about adjacent or "neighbor nodes", both child nodes (if any) and its parent node.
        *Note: 🖳 **End Device** nodes do not show parent PAN info, only "0" or "N/A" for entries.*
    - *If no nodes are selected* (click background), the table shows *all nodes* in the "Pan Network", including node status or fault cause. Values are derived from when a single node is selected, where the link quality is an average, and the sent/dropped packets are sums.
      Click on any table row to "blink" the text inside that node's shape in the node tree above.
    - If a *connection* between nodes is selected in the top pane, related PAN info data are listed in both link directions, as well as an LQI average between (to and from) connection links.

For more details, see:

- About Pan Sheet graphical representations
- Interpreting Link Quality (LQI)

About Pan Sheet graphical representations

- Nodes in Pan Sheet
- Links in Pan Sheet

Nodes in Pan Sheet

Each device node appears with a shape including its 802.15.4 MAC address (e.g. `00158d00:0009b50b`) and the NiagaraAX component name (or display name) of the SedonaJen6lpDevice component.

Node icons used in shapes and the bottom table vary by "device type", as follows:

- 📶 **Coordinator** (only one, at top) — For the JACE controller with Sedona Jennic option card.
- 🖳 **Router** — For a router-type device, specified in "Device Type" of the **SedonaJen6lpDevice**.
- 🖳 **End Device** — For an end device (or hibernating device) type, also specified in "Device Type."
- ❓ **Unknown** — A device with its **SedonaJen6lpDevice** component's "Device Type" property at "unknown" (default). Open the device's property sheet, and set to either "Router" or "End Device".

If a fully operational (connected) network, nodes in the top pane should all be connected within the node tree structure, with the coordinator at top. Each node should have only one parent (connection), and may optionally have one or more child connections to other nodes below.

Note it is possible for devices to appear in the Pan Sheet view *not connected* within the node tree—these devices are currently unconnected to the coordinator.

Also, one or more devices may be marked "down", which is indicated inside a node's shape: `down`

Links in Pan Sheet

Each link between nodes is indicated with a single connection line between node shapes, between the parent (top) node and the child (lower) node.

Connection lines are either green ✦ for strong links or yellow ✦ for weaker links.

Interpreting Link Quality (LQI)

The link quality metric for nodes is "LQI" (Link Quality Index), with a raw data range from 0 to 255. In the lower tabular pane of the Pan Sheet view, link quality is represented both graphically and in LQI:

Link Icon	Color	LQI
📶 4 bars	green	130 and above
📶 3 bars	yellow	71 - 130
📶 2 bars	orange	61 - 70
📶 1 bar	red	1 - 60
📶 0 bars	none	0

*Note:*   *The recommended minimum LQI for a solid network link is 70.*

Pan Sheet troubleshooting

The following notes describe some possible Pan Sheet issues along with recommended actions:

- **One or more nodes show status fault:** `Fault`
  This can happen if using Chopan for PAN info polling, and affected devices do not have the necessary kits (`chopan` and `paninfoChopan`) and/or app properly configured. You can either reconfigure the network's **Paninfo Poller** to use Sox for polling (set its "Use Chopan" property to `false`), or configure the Jennic-based devices to support Chopan PAN info polling. See "Configure router-capable Jennic-based devices for PAN info" on page 2.
- **Nodes not connected in node tree**
  This can happen from unfinished device joins or incomplete loading of PAN info data, and might occur if devices were recently moved or power cycled. In the Nav tree, right-click the **SedonaJen6lpNetwork** and select **Actions > Load All Paninfo**, and wait a minute or two before refreshing the Pan Sheet.
- **Node displays with two parents**
  Or the Pan Sheet shows other impossible tree configurations. In the Nav tree, right-click the **SedonaJen6lpNetwork** and select **Actions > Delete All Paninfo**, and then select **Actions > Load All Paninfo**. Wait a minute or two before refreshing the Pan Sheet.

PAN Info background

Every 802.15.4 network has a single "coordinator" node plus one or more other device nodes. In a network of Jennic-based Sedona Framework devices, the JACE station always operates as the coordinator, via the wireless Sedona Jennic option card installed in the JACE, and its station with SedonaJen6lpNetwork.

Device nodes below the coordinator may be routers or end devices. Each node has only one parent, and if a router, possibly one or more child nodes—each of which may also be either a router or end device. Essentially, this defines the "JenNet" tree architecture of wireless communications.

The following sections provide more details:

- What is JenNet?
- How do nodes form networks?
- PAN info data
- Pan info actions on Niagara components

What is JenNet?

"JenNet" is the Jennic protocol that manages 15.4 network formation and message routing. In the protocol stack, it sits above the 802.15.4 (physical) layer but below the 6LoWPAN/IP layer.

JenNet uses a "self healing tree" architecture. All messaging goes up and down the tree. Peer nodes do not communicate directly with each other, but instead through their parent. At the top of the tree is the coordinator node.

How do nodes form networks?

The following was taken from the *JenNet Stack User Guide*, JN-UG-3041, which at the time of this document is available at http://www.jennic.com/support/user_guides/jn-ug-3041_jennet_user_guide :

> Routers and End Devices can join an existing network already created by a Coordinator. Both Routers and the Co-ordinator have the capability to allow other nodes to join the network, but this feature of the node can be enabled or disabled (the node also has a maximum child capacity - see Section 2.2.3). The join process is as follows:
>
> 1. The new node first scans the available channels to find operating networks and identifies which one it should join. Multiple networks may operate in the same channel and differentiated by their Network Application IDs.
>
> 2. The node may be able to "see" multiple Routers and a Co-ordinator from the same network, in which case it selects which one it should connect to. This is determined by the following three criteria - first, the nodes highest up the tree are considered, then the one with the fewest existing children and, if there is still more than one candidate, the one with the strongest signal is selected.
>
> 3. The node then sends a message to the chosen Router/Co-ordinator, asking to join the network.
>
> 4. The Router/Co-ordinator determines whether it is currently allowing devices to join and ensures that it has not already reached its maximum number of children. If these criteria are satisfied, the Router/Co-ordinator then allows the device to join.
>
> 5. The stack sends a "Child Joined" notification message to the application on the Router/Co-ordinator, where this message contains the child's address.
>
> 6. The node is now connected to the network and ready to establish a route. The handshaking between parent and child when a new node joins the network is known as association.

Note that changes to the node hierarchy under the JenNet tree may, and often do, occur. This may happen because of changes in RF signal strength between nodes (say from a temporary interference) resulting in excessive packet losses, or as a consequence of a power event to one or more router nodes. When the reformation of nodes in the JenNet tree occurs, this can make some previously-captured "Pan info data" in the station invalid or "stale". For related details, see "PAN info data".

PAN info data

The coordinator and any router-capable Jennic device *internally* store various statistics about each "neighbor" child node that include the RF link quality, and numbers of message packets that are sent, received, and lost. For router nodes, these same statistics are stored on the device's single *parent* node. Devices that are "end devices" do not store any of this data.

In the JACE's Niagara station, this statistical data is modeled as "Pan Info" in dynamic components using a "neighbor entry structure".

* The SedonaJen6lpNetwork contains a **childPanInfo** component with an entry for each child.
* Each Sedona6lpDevice contains a **parentPanInfo** entry for its parent, *plus* a **childPanInfo** component for each of its children (if any).

Properties in this neighbor entry structure are as follows:

* Is Sleeping End Device — Whether device is a (hibernating) end device type (`true`) or a continuously powered device (`false`).
* Link Quality — Value between 0-255, representing strength of last packet received from this node. Values over 60 represent a good link. Also known as "LQI" (Link Quality Index).
* Packets Lost — Number of packets sent to device for which an ack(nowledgement) was not received. Note an ack is not expected on all packets.
* Packets Sent — Number of packets sent to device.
* Packets Received — Number of packets received from device.
* Mac154 — The unique 802.15.4 MAC address of the device, in hexadecimal notation without leading zeroes, for example: `158d00:9b017`
* Stale — Typically false, else true if this node entry is stale, meaning the device represented is no longer a child. For example, if a device resets and rejoins the JenNet network, it may have a new parent (say a router node). In this case, this Stale values shows true.

The Pan Sheet view of the SedonaJen6lpNetwork exposes most of this PAN info, along with a graphical representation of the node hierarchy in the JenNet tree for all connected nodes. For related details, see "Using the Pan Sheet" on page 3.

Pan info actions on Niagara components

There are related *actions* on the `SedonaJen6lpNetwork` and each `SedonaJen6lpDevice`:

- **Load All Pan Info**
  Forces a reload of PAN info from all child devices with PAN info (routers). If invoked on the SedonaJen6lpNetwork (coordinator), forces a reload of all coordinator and device PAN info.
- **Load Pan Info**
  Forces a reload of PAN info from the selected device (or if invoked on the SedonaJen6lpNetwork) the coordinator only.
- **Delete All Pan Info**
  Removes all *station* PAN info for all child devices with PAN info (routers). If invoked on the SedonaJen6lpNetwork (coordinator), removes all station PAN info for the coordinator as well as all device PAN info. Note this *does not remove the source data* in the Jennic-based devices.
- **Delete Stale Pan Info**
  Removes all station PAN info marked "stale" for all child devices with PAN info (routers). If invoked on the SedonaJen6lpNetwork (coordinator), it removes all station PAN info marked "stale" for the coordinator as well as any other stale device PAN info. Again, this has no affect on the source data in Jennic-based devices.

Document change log

Updates (changes/additions) to this engineering notes *Jennic Network Visualization (Pan Sheet)* document are listed below.

- Updated: February 14, 2014
  Added a single Note: on Sedona Framework TXS-1.2 installation topics for AX-3.7u1 and AX-3.8.

- Updated: January 23, 2013
  Very minor updates to mention Sedona Framework TXS 1.2 (requiring AX-3.7 or later). Note that screen captures were not updated to reflect a station running AX-3.7 with Sedona TXS 1.2 modules; however, all concepts and procedures in this document still apply.

- Publication: November 9, 2011
  Initial document.