

DustLink User's Guide

Advance Information

This document contains advance information of a product in development. All specifications are subject to change without notice. Consult LTC factory before using.

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1 About This Guide

1.1 Related Documents

The following documents are available for the SmartMesh IP network:

Getting Started with a [Starter Kit](#)

- [SmartMesh IP Easy Start Guide](#) - walks you through basic installation and a few tests to make sure your network is working
- [SmartMesh IP Tools Guide](#) - the Installation section contains instructions for the installing the serial drivers and example programs used in the Easy Start Guide and other tutorials.

User Guide

- [SmartMesh IP User's Guide](#) - describes network concepts, and discusses how to drive mote and manager APIs to perform specific tasks, e.g. to send data or collect statistics. This document provides context for the API guides.

Interfaces for Interaction with a Device

- [SmartMesh IP Manager CLI Guide](#)- used for human interaction with a Manager (e.g. during development of a client, or for troubleshooting). This document covers connecting to the CLI and its command set.
- [SmartMesh IP Manager API Guide](#) - used for programmatic interaction with a manager. This document covers connecting to the API and its command set.
- [SmartMesh IP Mote CLI Guide](#)- used for human interaction with a mote (e.g. during development of a sensor application, or for troubleshooting). This document covers connecting to the CLI and its command set.
- [SmartMesh IP Mote API Guide](#) - used for programmatic interaction with a mote. This document covers connecting to the API and its command set.

Software Development Tools

- [SmartMesh IP Tools Guide](#) - describes the various evaluation and development support tools included in the [SmartMesh SDK](#) , including tools for exercising mote and manager APIs and visualizing the network.

Application Notes

- [SmartMesh IP Application Notes](#) - Cover a wide range of topics specific to SmartMesh IP networks and topics that apply to SmartMesh networks in general.

Documents Useful When Starting a New Design

- The Datasheet for the [LTC5800-IPM SoC](#), or one of the [modules](#) based on it.
- The Datasheet for the [LTC5800-IPR SoC](#), or one of the [embedded managers](#) based on it.

- A [Hardware Integration Guide](#) for the mote/manager SoC or [module](#) - this discusses best practices for integrating the SoC or module into your design.
- A [Hardware Integration Guide](#) for the embedded manager - this discusses best practices for integrating the embedded manager into your design.
- A [Board Specific Integration Guide](#) - For SoC motes and Managers. Discusses how to set default IO configuration and crystal calibration information via a "fuse table".
- [Hardware Integration Application Notes](#) - contains an SoC design checklist, antenna selection guide, etc.
- The [ESP Programmer Guide](#) - a guide to the DC9010 Programmer Board and ESP software used to program firmware on a device.
- ESP software - used to program firmware images onto a mote or module.
- Fuse Table software - used to construct the fuse table as discussed in the Board Specific Integration Guide.

Other Useful Documents

- A glossary of wireless networking terms used in SmartMesh documentation can be found in the [SmartMesh IP User's Guide](#).
- A list of [Frequently Asked Questions](#)

1.2 Conventions Used

The following conventions are used in this document:

Computer type indicates information that you enter, such as specifying a URL.

Bold type indicates buttons, fields, menu commands, and device states and modes.

Italic type is used to introduce a new term, and to refer to APIs and their parameters.

 Tips provide useful information about the product.

 Informational text provides additional information for background and context

 Notes provide more detailed information about concepts.

 Warning! Warnings advise you about actions that may cause loss of data, physical harm to the hardware or your person.

`code blocks display examples of code`

1.3 Revision History

Revision	Date	Description
1	10/08/2013	Initial release

2 Introduction

DustLink is a web-based SmartMesh IP management application with the following features:

- Connects to an arbitrary number of SmartMesh IP managers.
- Gathers and displays information about motes, managers and networks.
- Displays the topology of the low-power wireless mesh networks.
- Stores and displays sensor data from arbitrary applications.
- Monitors the health of all connected networks.
- Bridges to the Xively cloud service as well as Google Spreadsheet to publish data.
- Uses advanced privileges for fine-grained user access management.

The application is written entirely in Python and is intended for use as a demo vehicle and a quick prototyping tool. DustLink can be installed on any computer that supports Python.

2.1 Using DustLink for Demos

DustLink is a simple demo vehicle. Connect your SmartMesh IP eval kit manager, navigate to the DustLink web page, turn on the motes and you're ready to do a demo. Use only the menu items and page sections highlighted green for demos . All non-highlighted items are for advanced use.



Note: Most of the information and examples detailed in this guide referring to mote behavior and applications is done in the context of the default full mote software running in Master mode. This default software is shipped as part of the SmartMesh IP evaluation kit motes, namely the DC9003A-B, DC9018A-B, DC9018B-B, as well as the LTP5901IPC-IPMAxxx#PBF and LTP5901IPC-IPMAxxx#PBF parts.

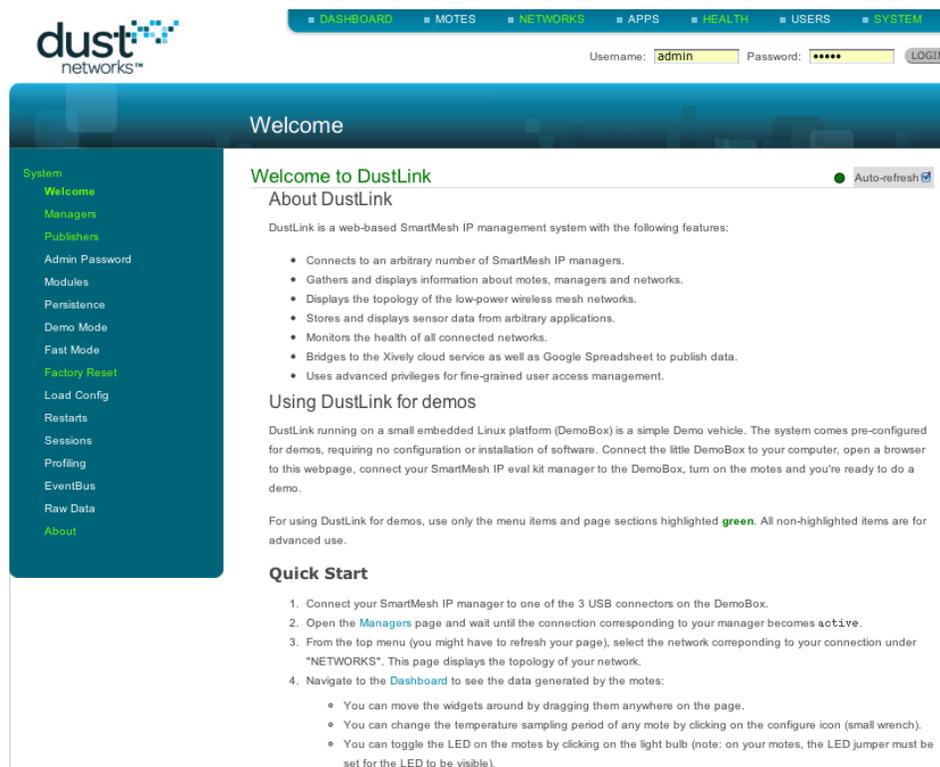
3 DustLink Quick Start Guide

The following steps will get you started with DustLink:

1. Install the necessary FTDI drivers and connect a SmartMesh IP Manager to your computer. See the [SmartMesh IP Tools Guide](#) for detailed driver installation instructions.
2. Install and start the DustLink web server as described at the [Installing on Your Computer](#) section of this guide.
3. On your computer, navigate to the DustLink website at the following address:

<http://127.0.0.1:8080/>

The following welcome screen appears:



The screenshot shows the DustLink web interface. At the top, there is a navigation bar with tabs for DASHBOARD, NOTES, NETWORKS, APPS, HEALTH, USERS, and SYSTEM. Below this is a login form with fields for Username (admin) and Password (masked with dots), and a LOGIN button. The main content area is titled 'Welcome' and contains the following sections:

- Welcome to DustLink**: A heading followed by an 'Auto-refresh' button.
- About DustLink**: A paragraph stating 'DustLink is a web-based SmartMesh IP management system with the following features:' followed by a bulleted list:
 - Connects to an arbitrary number of SmartMesh IP managers.
 - Gathers and displays information about motes, managers and networks.
 - Displays the topology of the low-power wireless mesh networks.
 - Stores and displays sensor data from arbitrary applications.
 - Monitors the health of all connected networks.
 - Bridges to the Xively cloud service as well as Google Spreadsheet to publish data.
 - Uses advanced privileges for fine-grained user access management.
- Using DustLink for demos**: A paragraph explaining that DustLink runs on a small embedded Linux platform (DemoBox) and is pre-configured for demos. It provides instructions on how to connect the DemoBox to a computer and use the web interface.
- Quick Start**: A section with a numbered list of steps:
 1. Connect your SmartMesh IP manager to one of the 3 USB connectors on the DemoBox.
 2. Open the **Managers** page and wait until the connection corresponding to your manager becomes active.
 3. From the top menu (you might have to refresh your page), select the network corresponding to your connection under "NETWORKS". This page displays the topology of your network.
 4. Navigate to the **Dashboard** to see the data generated by the motes:
 - You can move the widgets around by dragging them anywhere on the page.
 - You can change the temperature sampling period of any mote by clicking on the configure icon (small wrench).
 - You can toggle the LED on the motes by clicking on the light bulb (note: on your motes, the LED jumper must be set for the LED to be visible).

Figure 1 - Welcome page

Follow the instructions on the DustLink web page. DustLink is self documented - information about each menu and command is described in the website itself.

4 Installing on Your Computer

DustLink is a pure Python application. It requires Python 2.7.x. Python 3.x is not supported.

To run DustLink on your computer, you need to:

- Install Python (if not already installed on your computer)
- Unzip the DustLink zip file
- Install the required Python packages listed in the table below
- Start the DustLink program

DustLink requires several support packages in order to run:

package	homepage
pyserial	https://pypi.python.org/pypi/pyserial/
gdata	https://pypi.python.org/pypi/gdata/
PyDispatcher	https://pypi.python.org/pypi/PyDispatcher/
xively	https://pypi.python.org/pypi/xively-python/

These packages can be installed one of two ways:

- Manually - download each package from the python package index at <https://pypi.python.org/pypi> and install.
- Automatically - using the python installer tool [pip](#). Setup for automatic installation is discussed below.

4.1 Install Python



Many operating systems now come with Python installed. Refer to your computer's documentation to determine if you already have Python, in which case you can skip ahead to "Install DustLink".

1. Download Python - select a 32-bit version unless you have specific need to run a 64-bit version.
 - Choose 2.7.5 from <http://python.org/download/>.
 - Pick the installer corresponding to your laptop's operating system, e.g. `Python 2.7.3 Windows Installer` if you're running Windows.
2. Install Python.
 - Leave all options to their default value.
 - In particular, do **not** change the path Python will be installed in (e.g. `C:\Python27\`).

4.2 Install DustLink

Unzip the DustLink zip file in a convenient directory on your computer. No further installation is required.

4.3 Install setuptools and pip

 The following steps may require that you have write privileges for the installation directory (or directories), which will vary with your OS. This can be accomplished temporarily by using *sudo* in Linux.

Go to <https://pypi.python.org/pypi/setuptools/> and follow the installation instructions.

After setuptools has been installed, navigate to the Python\Script\ directory (or add it to the PATH environment variable) and install pip by typing

```
> easy_install pip
```

Alternately you can download and expand the pip tarball - <https://pypi.python.org/pypi/pip/>

- In a terminal or DOS command window, navigate to the pip folder and type

```
> python setup.py install
```

4.4 Install Additional Python Packages Using pip

Have pip install the remaining packages. The additional packages are found in the requirements.txt file (provided in the DustLink zip package). In a terminal or DOS console, navigate to the DustLink folder and type:

```
> pip install -r requirements.txt
```

4.5 Running the DustLink Web Server

Double-click on the DustLink-<version>\bin\dustLinkFullWeb\dustLinkFullWeb.py Python script (this may bring up the IDLE environment on some OSes). If you prefer to launch from a terminal or DOS command prompt, navigate to the \bin\DustLinkFullWeb folder in the DustLink folder and type:

```
> python dustLinkFullWeb.py
```

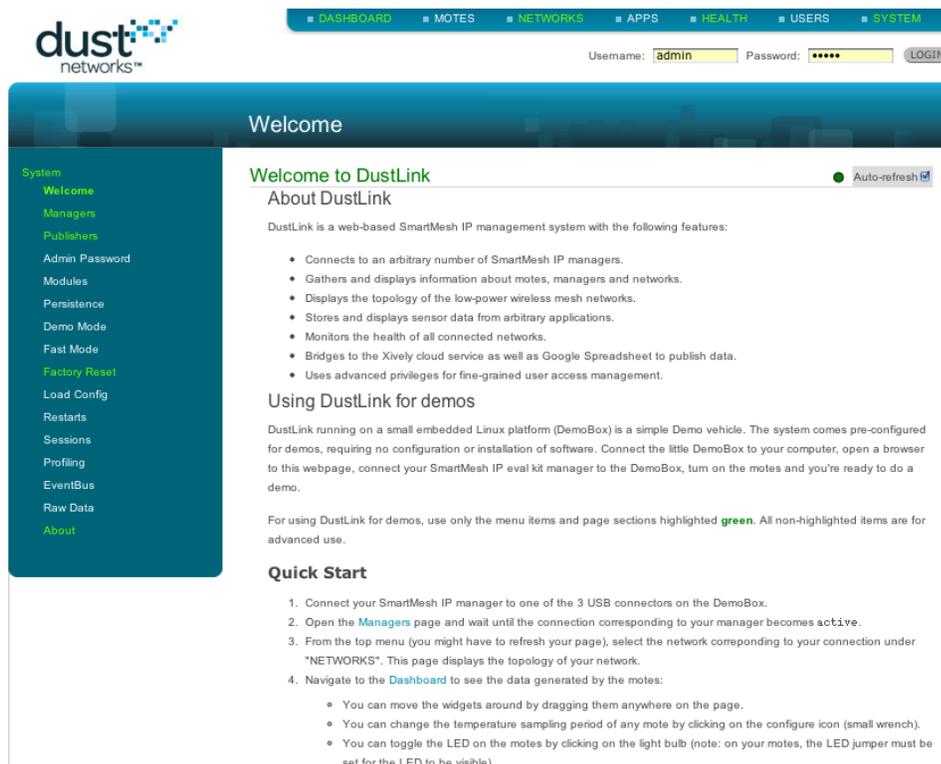
This starts the DustLink web server application.

The following prompt is presented to the user:

```
Dust Link - (c) Dust Networks
>
```

DustLink acts as a web server running on localhost (127.0.0.1) allowing you to interact with it using your web browser.

Point your browser to <http://127.0.0.1:8080/> to access DustLink's welcome screen.



The screenshot shows the DustLink web interface. At the top, there is a navigation menu with items: DASHBOARD, MOTES, NETWORKS, APPS, HEALTH, USERS, and SYSTEM. Below the menu, there are input fields for Username (admin) and Password (masked with dots), and a LOGIN button. The main content area is titled "Welcome" and contains the following sections:

- Welcome to DustLink**: A heading followed by an "About DustLink" section. Below this, it states "DustLink is a web-based SmartMesh IP management system with the following features:" and lists several bullet points:
 - Connects to an arbitrary number of SmartMesh IP managers.
 - Gathers and displays information about motes, managers and networks.
 - Displays the topology of the low-power wireless mesh networks.
 - Stores and displays sensor data from arbitrary applications.
 - Monitors the health of all connected networks.
 - Bridges to the Xively cloud service as well as Google Spreadsheet to publish data.
 - Uses advanced privileges for fine-grained user access management.
- Using DustLink for demos**: A section explaining that DustLink running on a small embedded Linux platform (DemoBox) is a simple Demo vehicle. It describes the pre-configuration and the steps to connect a SmartMesh IP eval kit manager to the DemoBox.
- Quick Start**: A section with a numbered list of steps:
 - Connect your SmartMesh IP manager to one of the 3 USB connectors on the DemoBox.
 - Open the **Managers** page and wait until the connection corresponding to your manager becomes active.
 - From the top menu (you might have to refresh your page), select the network corresponding to your connection under "NETWORKS". This page displays the topology of your network.
 - Navigate to the **Dashboard** to see the data generated by the motes:
 - You can move the widgets around by dragging them anywhere on the page.
 - You can change the temperature sampling period of any mote by clicking on the configure icon (small wrench).
 - You can toggle the LED on the motes by clicking on the light bulb (note: on your motes, the LED jumper must be set for the LED to be visible).

On the left side of the interface, there is a sidebar menu with items: System, Welcome, Managers, Publishers, Admin Password, Modules, Persistence, Demo Mode, Fast Mode, Factory Reset, Load Config, Restarts, Sessions, Profiling, EventBus, Raw Data, and About. The "Welcome" item is highlighted in green.

5 DustLink Quick Start Guide

The following walkthrough will show you how to:

- Connect DustLink to your manager
- View your network topology and individual motes
- View data trends and configure data reporting on a mote
- View a mote graphically in the dashboard
- Monitor network health

5.1 Connect DustLink to Your Manager

From the lefthand sidebar on the DustLink Welcome page, select **Managers**. This will take you to the Managers page, as shown in Figure 2. To add or delete a manager, you will first need to log in as an administrator, as describe in the [Admin User](#) section of this document.

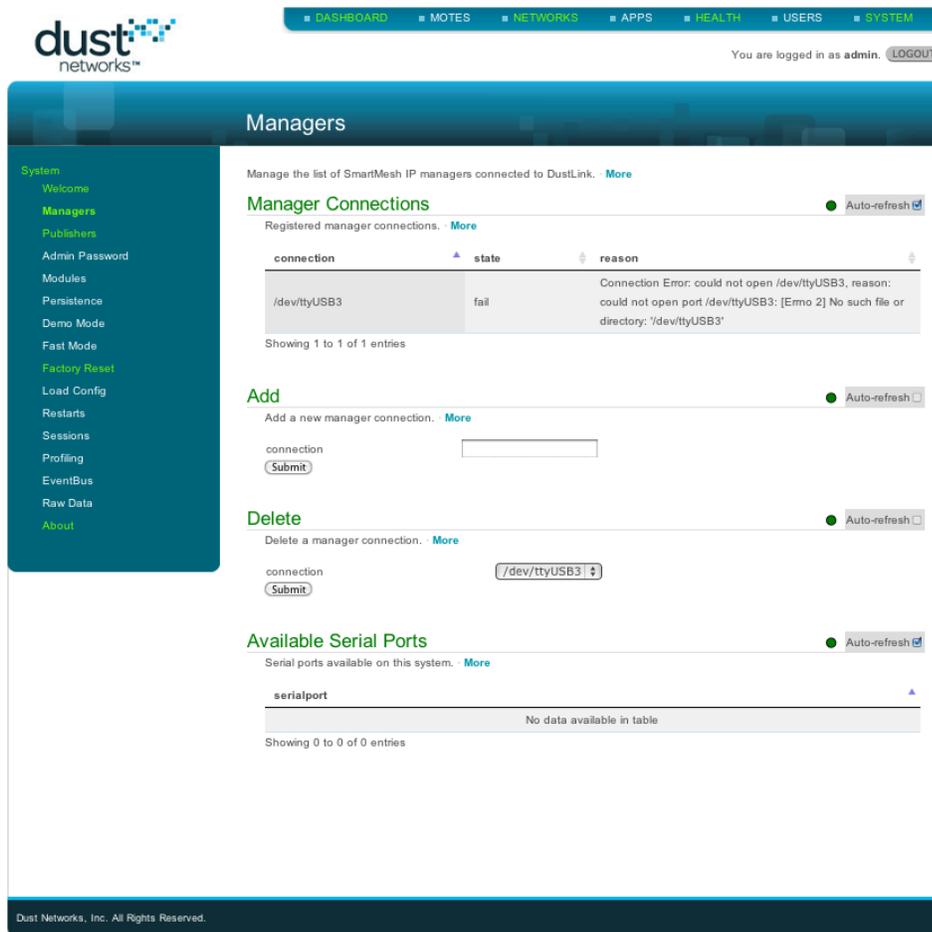


Figure 2 - Managers page

By default, DustLink is looking for a manager on the serial port /dev/ttyUSB3 - this is the default port when DustLink is installed on a eBox Linux embedded computer. To connect to your manager, you will need to enter the serial port for your manager - either a COM port in Window, or a different /dev/tty device under Linux/Mac OSX. See the [SmartMesh IP Tools Guide](#) for details on determining the serial port for your setup. Enter the manager serial port in the text box next to "connection" in the **Add** area and press the **submit** button. You should now see the manager listed with a status of **active** in the **Manager Connections** area. If you get an error, make sure that you have entered the port correctly, and that the manager is connected and powered on.

You can add multiple additional managers by repeating this process.

Optionally you can delete the default serial port /dev/ttyUSB3 from the pulldown connection menu in the **Delete** area and press **submit**. This step has absolutely no effect on the proper functioning of DustLink and is strictly cosmetic, limiting this table to list only those manager connections that are expected.

5.2 View Network Topology

Once you have powered on your motes and they have had a chance to join, you can view the topology of your network.

From the top menu, as you mouse over the **NETWORKS** tab, your manager's serial port should be listed below it. Select the serial port and it will load a page specific to that manager - you will see a topological map of the network under the Topology area. Note that the topology is drawn showing all connections as a hop which tends to exaggerate the depth of the network, as a device with the AP and a 1-hop mote as a parent will be shown at 2 hops, whereas on average it will likely have a hop depth of 1.3.

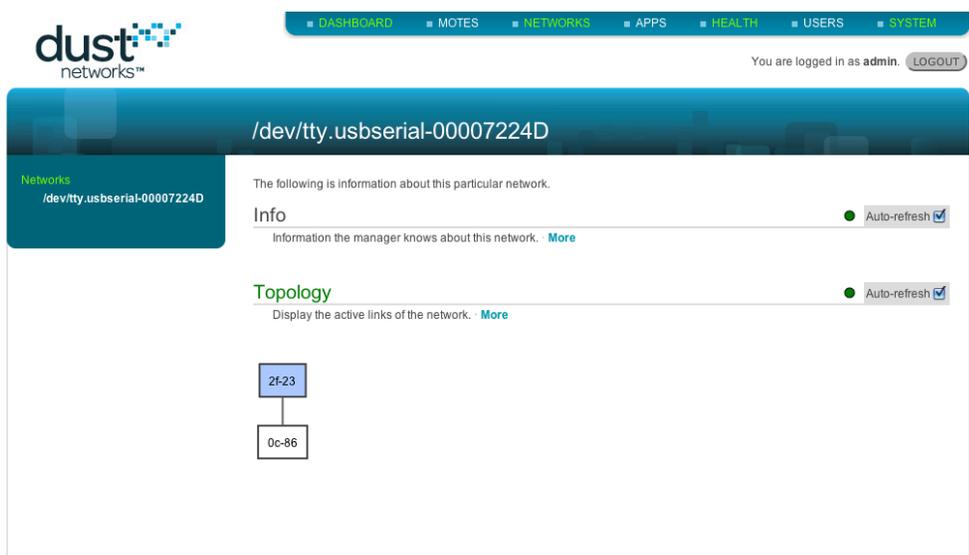
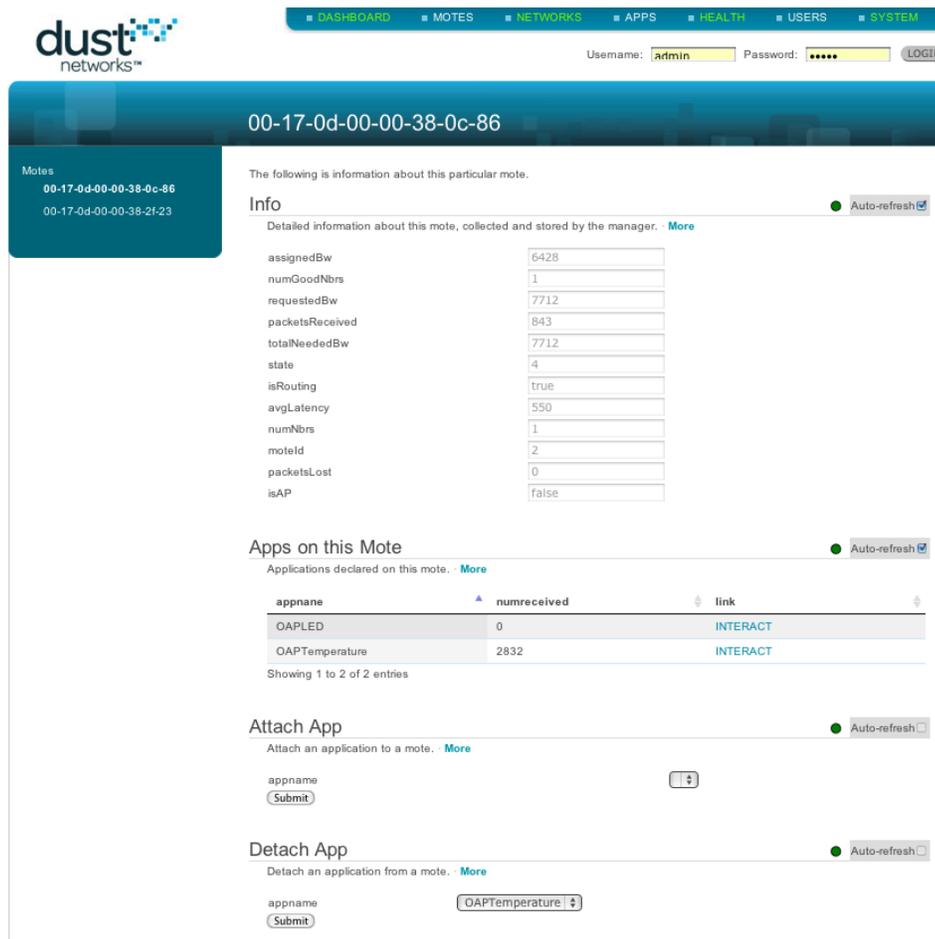


Figure 3 - Networks page

5.3 View Individual Notes

To view information about each mote, mouse over the **Motes** tab from the top menu. A list of MAC address will be shown below the tab - select one to bring up a page specific to that mote.



The screenshot shows the DustLink web interface. At the top, there is a navigation menu with tabs for DASHBOARD, MOTES, NETWORKS, APPS, HEALTH, USERS, and SYSTEM. Below the menu is a login form with fields for Username (admin) and Password (*****), and a LOGIN button. The main content area is titled '00-17-0d-00-00-38-0c-86' and contains several sections:

- Motes**: A sidebar menu with the selected mote '00-17-0d-00-00-38-0c-86' and another mote '00-17-0d-00-00-38-2f-23'.
- Info**: A section titled 'The following is information about this particular mote.' containing a table of statistics:

assignedBw	6428
numGoodNbrs	1
requestedBw	7712
packetsReceived	843
totalNeededBw	7712
state	4
isRouting	true
avgLatency	550
numNbrs	1
moteId	2
packetsLost	0
isAP	false
- Apps on this Mote**: A section titled 'Applications declared on this mote.' containing a table:

appname	numreceived	link
OAPLED	0	INTERACT
OAPTtemperature	2832	INTERACT
- Attach App**: A section for attaching an application to a mote, with a text input for appname and a Submit button.
- Detach App**: A section for detaching an application from a mote, with a dropdown menu for appname (showing OAPTtemperature) and a Submit button.

Figure 4 - A Mote page

It contains a number of areas:

- Info - Contains various statistics about the mote obtained when it joined and from Health reports.
- Apps on this Mote - Contains the list of applications that are running on this mote and are attached to DustLink. It is important to understand that only applications that have been "Attached" will be listed in this table and active. The default motes purchased pre-programmed from Linear, either in evaluation kits or as individual products, contain a number of applications ranging from temperature reporting to I/O controls. Refer to the [SmartMesh IP Tools Guide](#) for more details on mote applications. This version of DustLink supports two of those applications when the mote is running in Master mode, namely the OAPTtemperature and OAPLED applications. For the advanced programmer, DustLink can be quickly enhanced to attach to the other default mote applications OR any application being developed on the mote using the SmartMesh IP on-chip SDK.

- Attach App - allows you to attach an app that was previously detached.
- Detach app - allows you to detach an app that was previously attached.

Note that if the mote has just joined, you may only see a the **numOperationalEvents**, **moteState**, and **moteld** fields under Info, and the Attach and Detach Apps areas may not correctly reflect the app state. You will need to update the page manually or select **Auto-refresh** in order to see the Attach/Detach fields updated correctly.

5.4 Viewing Data Trends and Configuring Data Reporting on a Mote

DustLink allows you to interact with the data applications on the mote by selecting **INTERACT** from the links column of the table found in the **Apps on this Mote** area of a mote's page.

Selecting **INTERACT** for the OAPLED app allows you to turn the blue INDICATOR_0 LED on the mote on and off. Entering 1 in the status field and pressing the **submit** button will turn it on (after a short delay since the command is sent over the air to the mote), while entering 0 will turn it off (again after a short delay). Note that the LED_ENABLE jumper must be shorted to see the LEDs.

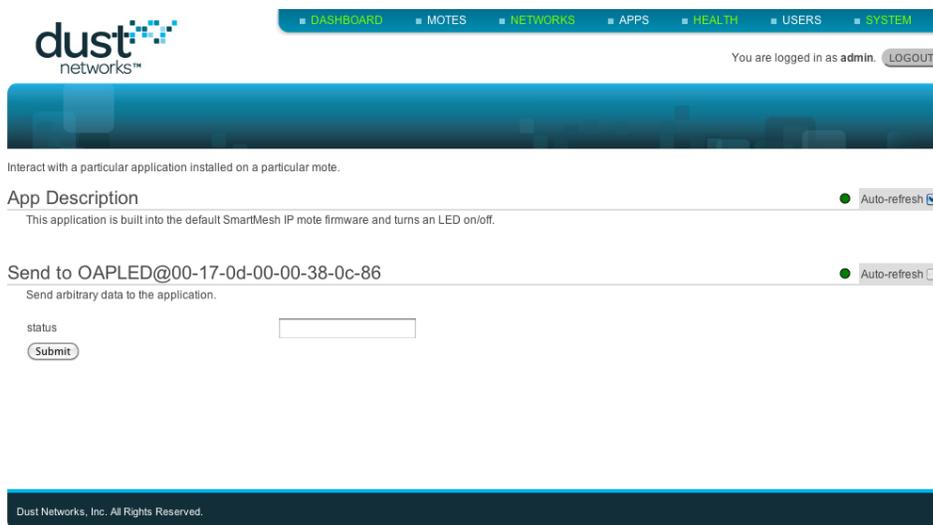


Figure 5 - The OAPLED app page

Returning to the mote's page, selecting **INTERACT** for the OAPTemperature app will bring up a page, as shown in Figure 5.

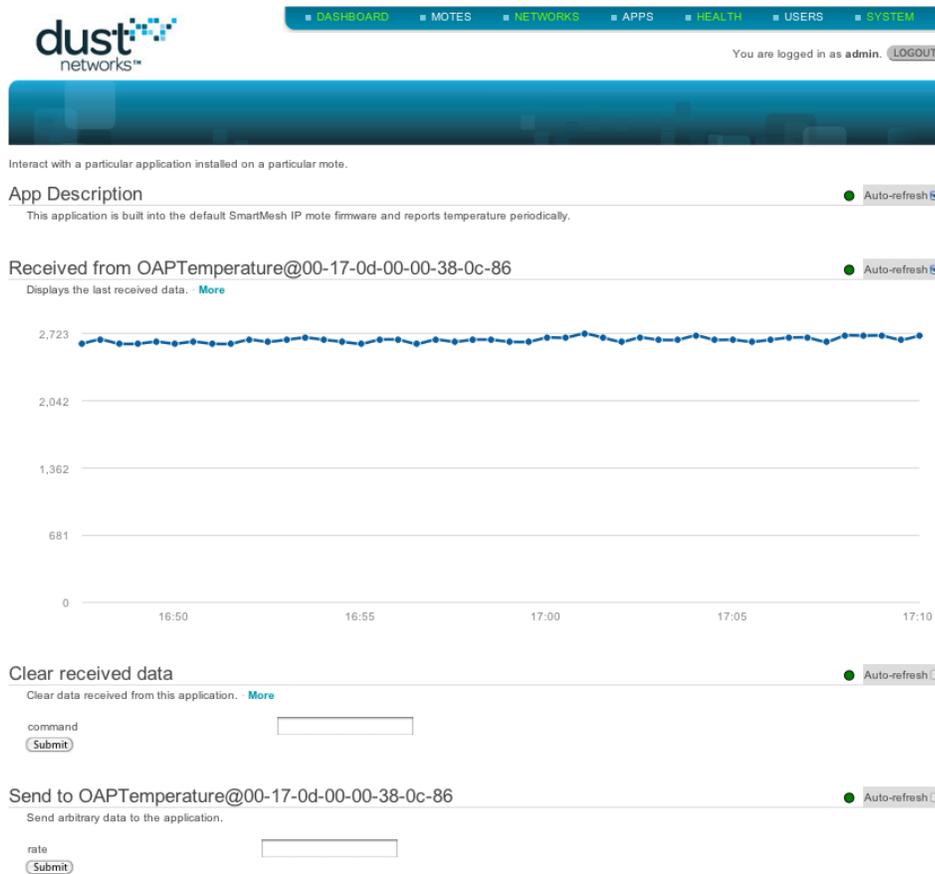


Figure 6 - The OAPTemperature app page

A graph of the temperature (reported in raw units - 1/100 of a °C for motes at revision > 1.3) versus time is shown in the **Received from OAPTemperature@MAC** area.

There is a **Clear received data** area to clear the data history, and a **Send to OAPTemperature@MAC** area to configure the reporting rate of the OAPTemperature app. To change from the default 30 s rate, enter a new value of 10000 (ms) in the **rate** field and press submit - this changes the reporting rate to 10 s. You can heat or cool the mote to see the graph change more dramatically.

5.5 View a Mote in the Dashboard

You can also view motes graphically from the Dashboard - select **DASHBOARD** from the top menu. You will see a page tiled with widgets corresponding to each mote's active applications. An example is shown in figure 7, where there are two widgets corresponding to the OAPLED and OAPTemperature apps. Clicking on the OAPLED lightbulb will allow you to toggle the INDICATOR_0 LED on your mote. The temperature widget will toggle color and update the temperature every time a packet is received from the mote.

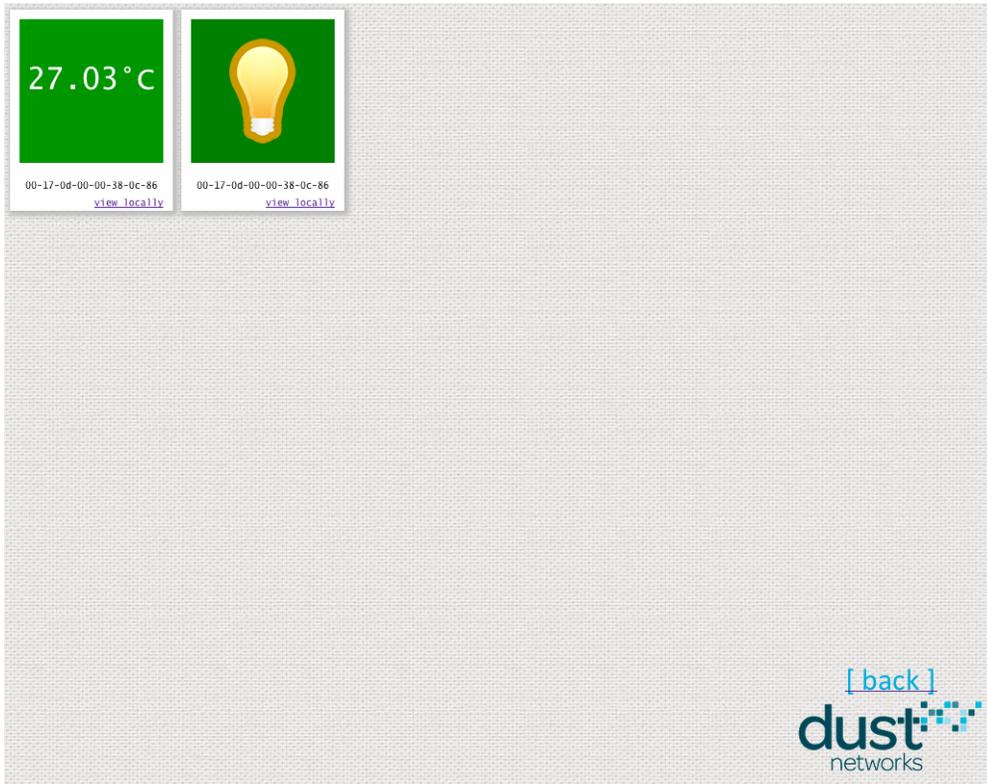


Figure 7 - The Dashboard

Selecting the **view locally** link on a widget will take you back to the same page you reached by selecting **INTERACT** from the links column of the table found in the **Apps on this Mote** area of a mote's page. Selecting the **back** link will take you to back to the Welcome page.

5.6 Monitor Network Health

DustLink monitors the state of the network by gathering statistics from mote health reports. DustLink runs various tests on the current state of the network. Passing these tests are a good indicator of network health. Selecting **HEALTH** from the top menu brings you to a page similar to that shown in Figure 8.

Health /dev/tty.usbserial-00007224D

Network health information for the selected network. [More](#)

Test schedule Auto-refresh

Test schedule controls. [More](#)

period (min)

next test in

[Run tests now](#)

Test Results Auto-refresh

Test results and status. Click on any item for details. [More](#)

S	W	Test Name	Last Run	Last Success	Last Failure
		oneSingleParentMote	10/11/2013 15:38:01	10/11/2013 15:38:01	N/A
		numLinks	10/11/2013 15:38:01	10/11/2013 15:38:01	N/A
		multipleJoins	10/11/2013 15:38:01	10/11/2013 15:38:01	N/A
		stabilityVsRssi	10/11/2013 15:38:01	N/A	N/A
		networkReliability	10/11/2013 15:38:01	10/11/2013 15:38:01	N/A
		numGoodNeighbors	10/11/2013 15:38:01	N/A	10/11/2013 15:38:01
		networkAvailability	10/11/2013 15:38:01	N/A	N/A
		perMoteAvailability	10/11/2013 15:38:01	N/A	N/A

Reset tests Auto-refresh

Reset all test statuses and results. [More](#)

some tests failed for network /dev/tty.usbserial-00007224D [close](#)

Figure 8 - Health testing

You can configure the rate at which DustLink runs these tests, however there is little benefit to running them faster than the default, as a stable network changes very slowly. The **Run tests now** button however will give you immediate feedback on the state of your network.

Clicking on a **Test Name** will bring up a tooltip explaining what is being tested. In the example in Fig. 8, we see a cloud (failure) for the numGoodNeighbors test - the tooltip tells us:

This test verifies that each mote has enough good neighbors.

The manager can build a robust network if each mote in the network has at least MIN_NUMGOODNEIGHBORS neighbors.

This test is run once for each mote in the network.

Since MIN_NUMGOODNEIGHBORS is 3 by default, the single mote network shown here cannot ever satisfy this test. Were we to see this test fail in a 5-mote network, it means that at least some motes are too far apart from each other.

5.7 What Next?

DustLink contains many advanced features. Some of the things you can do with DustLink:

- Stream data to an external xively repository or google spreadsheet - see the online DustLink tool tips under the **Publisher** tab
- Create a data parser "app" to display formatted data coming from a sensor processor
- Configure DustLink (accounts, data persistence, etc.)

6 Admin User

By default, when you load the DustLink web page, you are not logged in, which restricts your ability to make changes.

The `admin` user has all privileges. Use the following credentials to log in as the `admin` user:

Username	Password
<code>admin</code>	<code>admin</code>

7 Updating DustLink

The DustLink website is distributed as a single zip file. To upgrade to a new version, one need only download the latest release and unzip. If new python packages are needed (see the release notes in the zip file) then install them with pip as described in [Installing on your Computer](#).

 Updating DustLink will remove all the internal data, including users, motes and networks.

Once DustLink has fully booted, point your computer's browser to 127.0.0.1:8080. In the `System > About` page, the DustLink version corresponds to the new version installed.

Versions

 Auto-refresh

component	version
DustLink	1.0.1.22
SmartMeshSDK	1.0.3.70

Showing 1 to 2 of 2 entries

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