SERIAL MUX

Setup Guide

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INTRODUCTION

The Serial Mux user module is a software application that runs in B+B SmartWorx routers equipped with the Dust Smartmesh IP wireless mesh network radio technology from Linear Technology. By running the Serial Mux application the router becomes a gateway for any Dust Smartmesh IP nodes running the dust message protocol, such as the DC9003 or DC2126 available from Linear Technology, or any nodes designed using Smartmesh IP and the Dust message protocol. In addition to compatibility with those nodes, the gateway also enables software such as Dust Link, Stargazer or other demo software to be used.

With the Serial Mux user module and the Spectre router, designers can go from proof of concept to production without the expense of gateway design.

The *Serial Mux* user module is not part of the router's firmware. Detailed information about installing user modules in the router is described in the Configuration Manual. This document is located on the advantech-bb.com website, just search for Wzzard and view the documentation. This user module is compatible only with routers running firmware v5.1.3, or later. This user module will only work properly on routers that have the Dust expansion board installed.

Serial Mux user module contains the Serial Mux (Serial API Multiplexer) application; a simple multiplexer for communication with the SmartMesh IP Manager of the Dust expansion board. Serial Mux allows multiple applications to simultaneously communicate with the SmartMesh IP Manager's Serial API over a TCP connection. Figure 1 shows an overview of applications that can communicate with the Serial Mux user module. The applications include: DC2126A application of the SmartMesh SDK and Dust Link application. In addition, custom applications can communicate with the Serial Mux using the Serial Mux protocol.

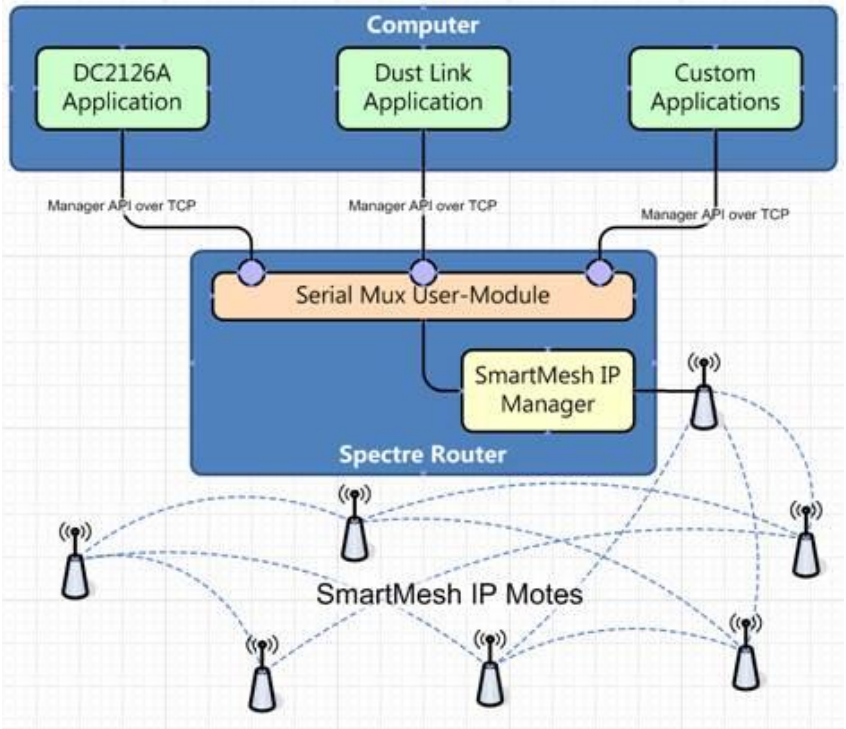

Figure 1: System Overview

SERIAL MUX USER MODULE

INSTALL SERIAL MUX USER MODULE

This section describes how to install the Serial Mux user module on the SPECTRE router. The Serial Mux user module requires that the SPECTRE router is running router firmware version 5.1.3, or later.

The SPECTRE router's firmware version number is located under System Information of the General Status page. If the router's firmware version is older than 5.1.3, then the router's firmware must be updated.

1. If required, update the router's firmware:
    a. Search for and download the model-specific firmware for the SPECTRE router from advantech-bb.com
    b. Go to the router's Update Firmware page.
    c. Select the downloaded firmware file.
    d. Press the **update** button to update the router's firmware.
2. Set the Netid and Join Key on the IoT Gateway User Module to match the nodes will be attaching to the gateway. The default settings of the DC2126A device are shown below.
    a. From the router's General Status page, click on User Modules. Click IoT gateway User Module.
    b. Set **Netid** to 1229
    c. Set **Join Key** to 445553544E4554574F524B53524F434B
    d. Click **Save**
3. View the system log on the SPECTRE router:
    a. From the router's General Status page, click on System Log.
    b. Verify the netid has been updated by finding the following line in the system log:
    `NOTICE: netId is 1981, but should be 1229; change netId.`
    c. Verify the join key has been updated by finding the following line in the system log:
    `NOTICE: Update common join key, and then restart the Dust Network.`
    d. Verify the DC2126A device has joined the network. The 6 characters highlighted in the example below will match the label on the DC2126A device.
    `NOTICE: EventMoteJoin (00170d0000604252)`
4. The Serial Mux user module cannot be used at the same time as the IoT Gateway user module.
    a. From the router's General Status page, click on User Modules. If the IoT Gateway user module is installed, delete it by pressing the Delete button next to the user module.[1]
5. To install the Serial Mux user module:
    a. Search for Wzzard and download the Serial Mux user module from advantech-bb.com
    b. Extract the ZIP archive containing the user module.
    c. Select the extracted user module on the User Modules page.
    d. Press the **Add or Update** button.

[1] Wzzard sensor nodes require the IoT Gateway user module. Deleting the IoT Gateway user module disables communication with the Wzzard sensor nodes. You can easily re-install the IoT Gateway user module if desired.

CONFIGURE SERIAL MUX USER MODULE

Figure 2 displays the configuration page of the Serial Mux user module. It contains settings to configure the Serial Mux.

Figure 2: Serial Mux User Module

In the configuration page of the Serial Mux:

1. Verify Remote Connections is set to “On”. This will allow applications running outside of the router to connect to Serial Mux.
    a. When Remote Connections is set to “Off”, only applications running on the router can access Serial Mux.
2. Set the TCP Port number that Serial Mux uses to listen for connections.
    a. The default TCP Port for Serial Mux is 9900. The examples in this document will use this default port.
    b. The TCP Port number must be one that is not in use by another service on the router; for example, the router may use TCP ports 22 (SSH), 23 (TELNET), 80 (HTTP) and 443 (HTTPS).
3. Press the Save button, and the Serial Mux user module will restart and use the new settings.

RUNNING LINEAR TECH SOFTWARE APPLICATIONS ON YOUR PC

PREREQUSITES

The DC2126A and Dust Link applications available from Linear Technology discussed in this document require Python 2.7 to be installed. Note that the applications do not run with Python 3.x.

INSTALL PYTHON 2.7

To install Python 2.7 on Microsoft Windows:

1. Download the latest version of Python 2.7 from
   https://www.python.org/downloads/
   This example shows installation of Python 2.7.10.
2. Double-click on the downloaded file; e.g.,
   a. On 32-bit version of Microsoft Windows, double-click on `python-2.7.10.msi`.
   b. On 64-bit version of Microsoft Windows, double-click on `python-2.7.10.amd64.msi`.
3. Follow the on-screen directions to install the software.
   a. Figure 3 shows the Customize Python screen of the installer.
   b. Make sure to enable "Add Python.exe to Path" as shown in Figure 4.

Figure 3: Customize Python

Figure 4: Customize Python with Add Python.exe to Path

DC2126A APPLICATION

The DC2126A application is a simple program to communicate with the Linear Technology's DC2126A, "High-Accuracy Wireless Temperature Sensor with Solar Battery Life Extender".

INSTALL DC2126A APPLICATION

The DC2126A application is included in the SmartMesh SDK.

1. Download the SmartMesh SDK from: http://www.linear.com/docs/43297
2. Extract the ZIP archive to a convenient location on your computer.
3. The DC2126A.exe program is found in the `/win` directory of the extracted SmartMesh SDK folder.

CONNECT DC2126A APPLICATION TO SERIAL MUX

The DC2126A application can connect to the Serial Mux user module.

1. Ensure that Serial Mux user module is installed in the SPECTRE router.
2. Turn on the DC2126A device.
3. In the `/win` directory of the SmartMesh SDK folder, double-click on `DC2126A.exe`. (Note: when file extensions of known file types are hidden, the `exe` extension will not be shown in Windows Explorer.)
4. A window similar to the one in Figure 5 will open.

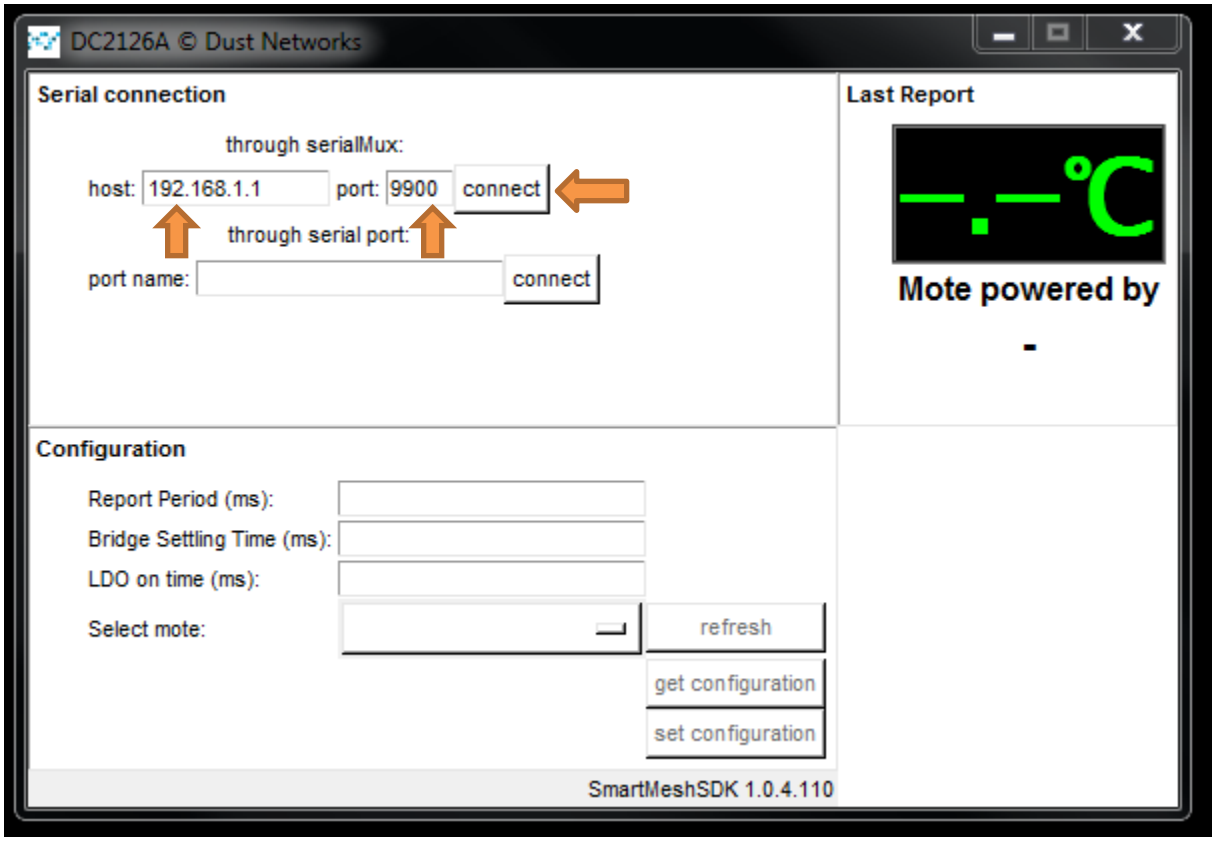

Figure 5: Connect to DC2126A

5. Enter the IP address of the SPECTRE router in the **host** field; e.g., **192.168.1.1**.
6. Enter the TCP port that the Serial Mux user module uses to listen for connections in the **port** field; e.g., **9900**.
7. Click the **connect** button.
8. When the DC2126A application connects to the Serial Mux user module, **Connection successful** will be displayed as shown in Figure 6.

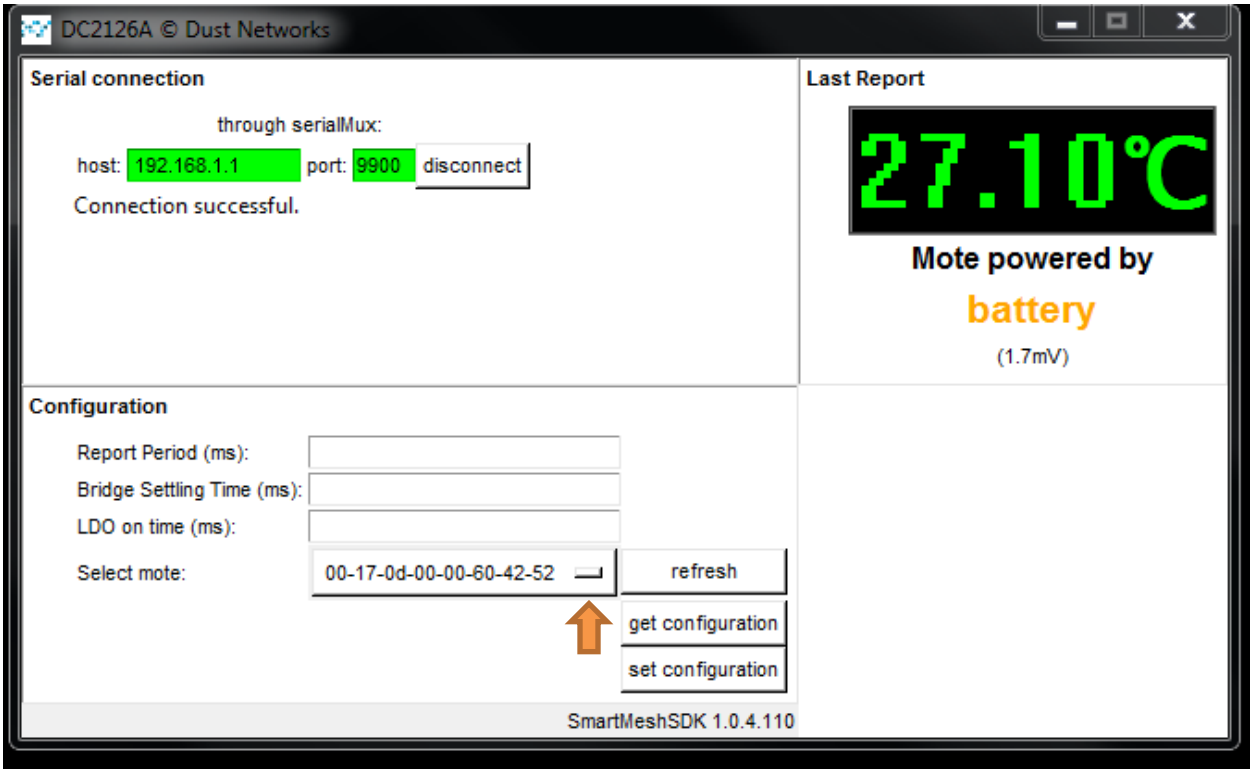

Figure 6: Successfully Connected to DC2126A

CONNECT TO A DC2126A

1. Select the DC2126A by using the **`Select mote`** drop-down list.
    a. The drop-down list is populated with the MAC address of motes that are on the SmartMesh IP network.
2. The temperature and power source in the **`Last Report`** display section will blink when new data is received from a selected device.

DUST LINK

The Dust Link application is a demo application for communicating with the SmartMesh IP network.

INSTALL DUST LINK

The complete instructions for Dust Link are in the Dust Link User's Guide. The following is included here to get running quickly.

1. Download Dust Link release 1.0.2.63 from
   https://github.com/dustcloud/Dust Link/releases
   or search for Wzzard on the advantech-bb.com site.
2. Extract the downloaded ZIP archive, `Dust Link-REL-1.0.2.63.zip`. These instructions will assume that the files in the archive were extracted to `C:\Dust Link-REL-1.0.2.63`.

3. Open a Command Prompt window. (From the Start Menu, choose All Programs | Accessories | Command Prompt.)
4. Change to the directory where the archive files were extracted. In the Command Prompt window, type:
   `cd /d "C:\ Dust Link-REL-1.0.2.63"↩`
5. Install the Python modules required by Dust Link. In the Command Prompt window, type:
   `pip install -r requirements.txt↩`

RUN AND CONFIGURE DUST LINK

After Dust Link has been installed, Dust Link can be run by:

1. Via a command window, change to the following directory
   `C:\dustlink-REL-1.0.2.63\bin\dustLinkFullWeb`
2. Execute the following command
   `python dustLinkFullWeb.py↩`
3. If a Windows Security Alert dialog box comes up, let the Windows Firewall allow access to the network for `python.exe`. The Security Alert message is displayed, because the Python script creates a web-server for the Dust Link web-application).
4. Using a web browser, go the URL http://127.0.0.1:8080/
5. Enter the username and password, and then click the Login button. The default username is **`admin`** and the default password is `admin`.
6. From the Dust Link menu bar, choose **`System`** | **`Managers`**.
7. Under the Delete section, click the Submit button to delete the default manager connection. After this, the Manager Connections will show that there are no manager connections.
8. Under the **Add** section, add an entry for the SPECTRE router in the format of <router_ip>:<tcp_port>
   a. For example: **`192.168.1.1:9900`**
   b. Then click the **`Submit`** button in the **Add** section
9. Wait for the state of the new connection to show active.
10. From the Dust Link menu bar, choose **`Networks`** | **`192.168.1.1_9900`**. This will show the topology of the active links of the network. See Figure 7.
11. SmartMesh IP network health information is available under **`Health`** |**`192.168.1.1_9900`**.
12. From the Dust Link menu bar, choose **`Motes`** | **`<Mote MAC Address>`**. This will give you detailed information about this mote.

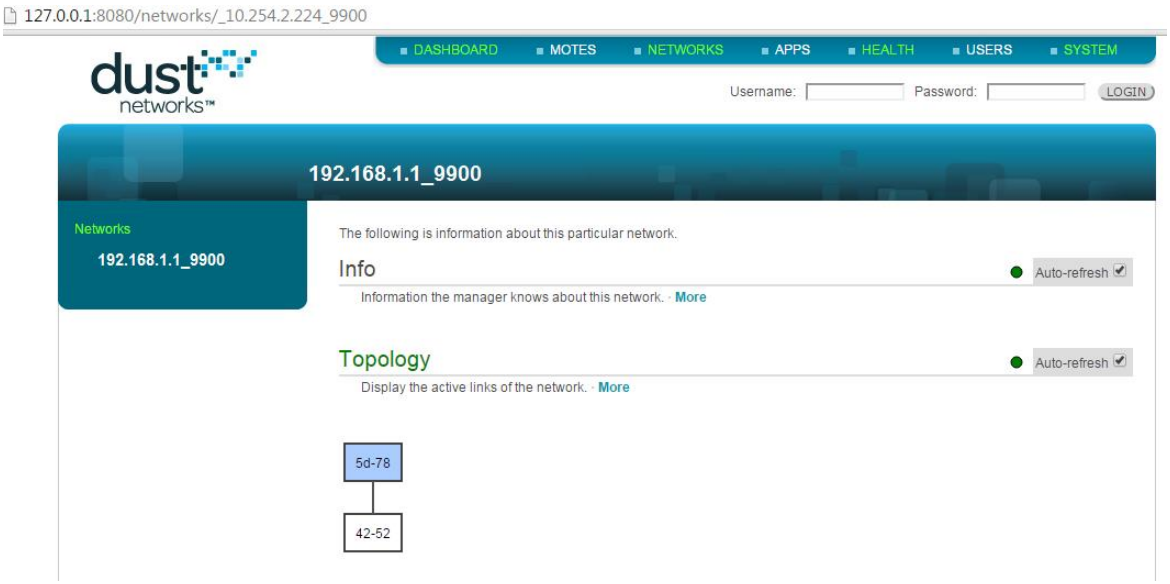

Figure 7: Dust Link Network

13. From the Dust Link menu bar click on **APPS** | **DC2126A**. This will display the screen shown in Figure 8.

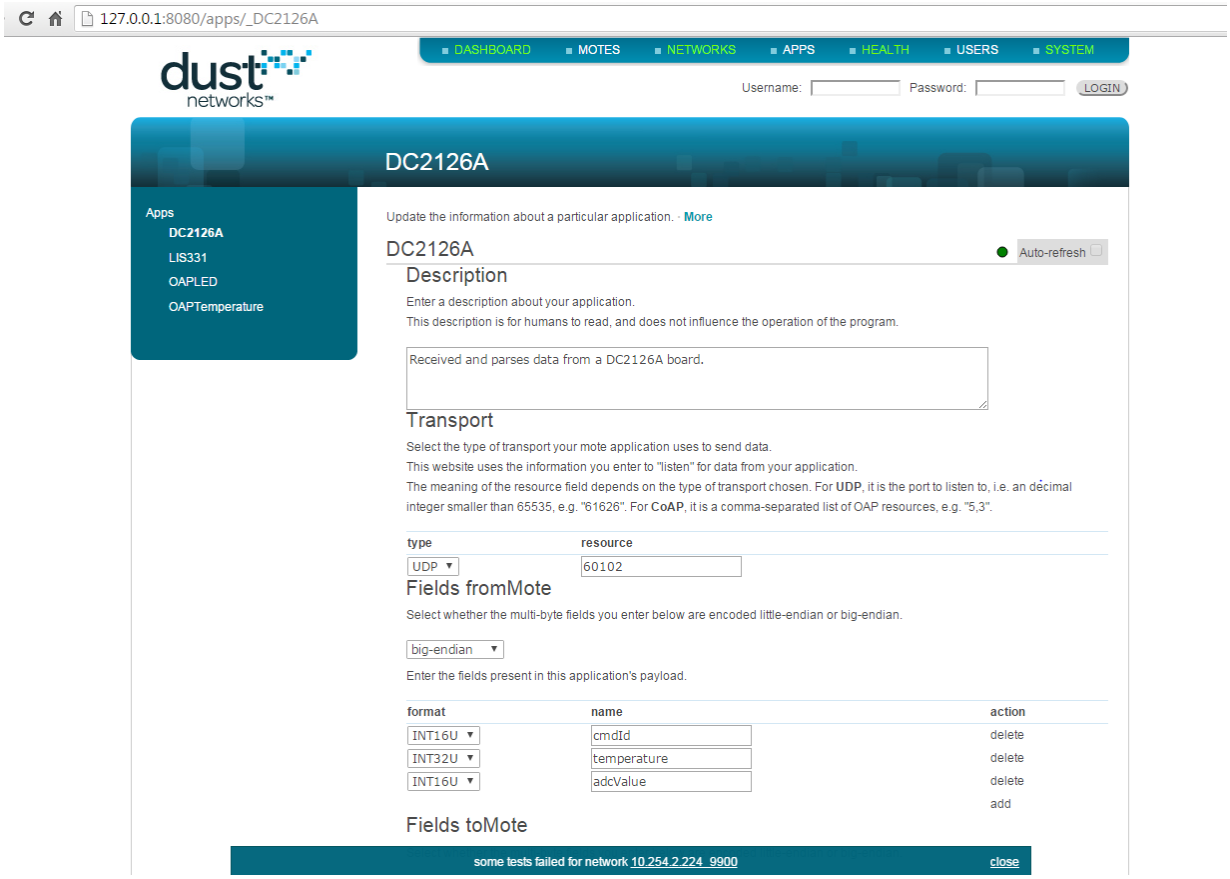

Figure 8: Dust Link DC2126A App

14. From the Dust Link menu bar click on **Dashboard**. When the DC2126A is on the SmartMesh IP network, this will display the screen shown in Figure 9.

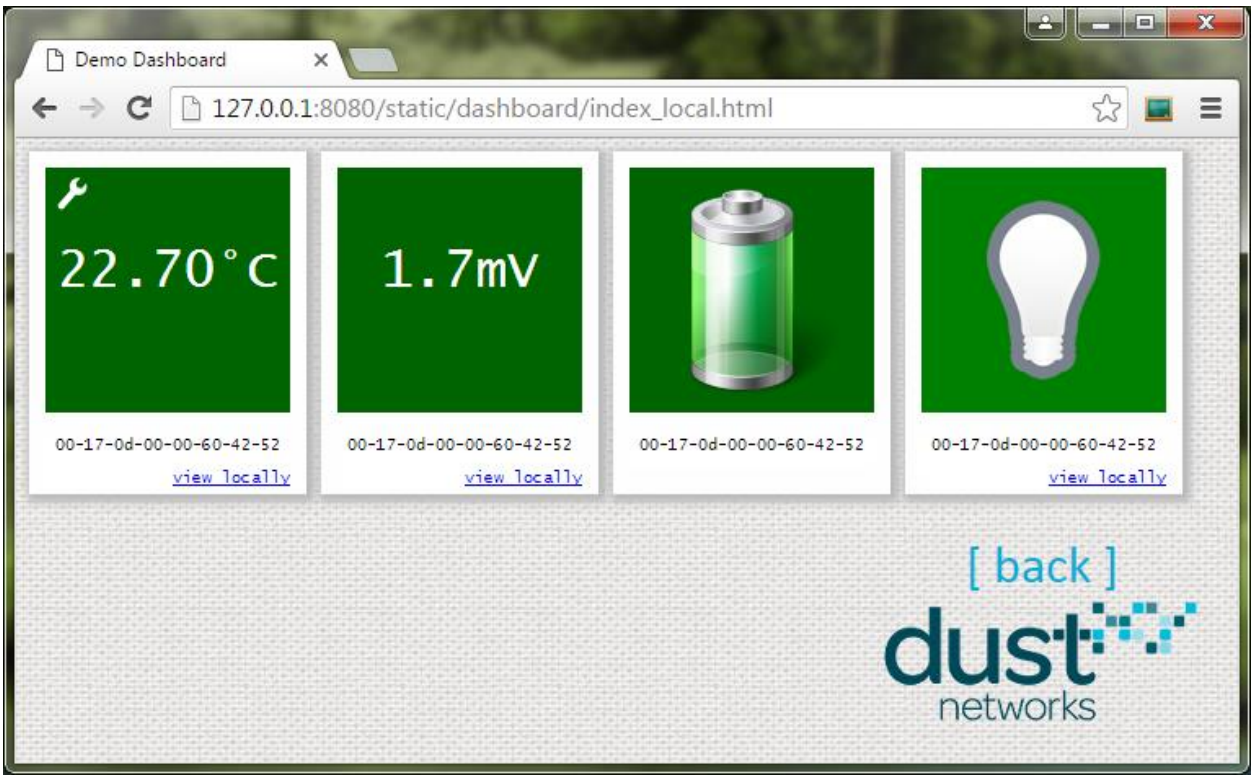

Figure 9: Dust Link Dashboard

SERIAL MUX PROTOCOL

The Serial API Multiplexer (Serial Mux) provides an API similar to the SmartMesh IP Manager Serial API with some changes to the messaging protocol and a few of command extensions. The Serial Mux uses a TCP connection with a client instead of connection to the Manager's serial port. With the exception of the protocol layer changes, a client can communicate with the Serial Mux in much the same way that it would communicate with the SmartMesh IP Manager.

BASIC OPERATION

The Serial Mux tries to connect to the Manager immediately when it starts. If the Serial Mux cannot connect, it periodically retries until a connection is established. After connecting to the SmartMesh IP Manager, the Serial Mux listens on a well-known, configurable port for TCP connections from clients.

When a client connects, the client is expected to send a Hello message to the Serial Mux. The Hello message contains a token that indicates the client is authorized to connect and the client's protocol version. If the token or protocol version doesn't match, the Serial Mux sends a Hello Response with an error status and terminates the connection. Otherwise, the Serial Mux waits for client commands to forward to the Manager.

The Manager Serial API can only process one outstanding request at a time, so clients should limit the rate that requests are sent to the Serial Mux. The Serial Mux will only read a single request at a time from a client's TCP connection. While servicing requests from clients one at a time, the Serial Mux reads from the SmartMesh IP Manager Serial API. Responses are routed to the appropriate client. Notifications are copied to all subscribed clients and acknowledged to the SmartMesh IP Manager Serial API. Clients write requests and read both responses and notifications from the same TCP connection to the Serial Mux. If the Serial API connection with the Manager resets, the Serial Mux will close any open API clients and reconnect to the Manager. It is the responsibility of the client to reconnect with the Serial Mux.

PROTOCOL

Requests and responses have a short header to identify a message within the TCP stream. The command type precedes the message data. The command types and associated request and response data are the same structures used in the Linear Tech SmartMesh IP Embedded Manager API Guide with the addition of the Hello and Info messages described below.

REQUEST FORMAT

Parameter	Type	Description
header	INT8U[4]	4 byte message start sequence
length	INT16U	Length of the remainder of the message
reserved	INT16U	Reserved. Must be set to zero.
commandType	INT8U	Command type as described in Serial Mux Command Types.
Data	INT8U[]	Request data as described in SmartMesh IP Embedded Manager API Guide.

Figure 10: Serial Mux Protocol Request Format

RESPONSES FORMAT

Parameter	Type	Description
header	INT8U[4]	4 byte message start sequence
length	INT16U	Length of the remainder of the message.
reserved	INT16U	Reserved. Set to 0.
commandType	INT8U	Command type as described in Serial Mux Command Types
Data	INT8U[]	Response data as described in SmartMesh IP Embedded Manager API Guide. This includes the response code.

Figure 11: Serial Mux Protocol Response Format

SERIAL MUX DEFINITIONS

This section lists constants and pre-defined values used in the API structures.

PROTOCOL CONSTANTS

The Serial Mux message header is the 4 byte sequence shown in Figure 12. The header is used to identify a message within the TCP stream.

Byte 1	Byte 2	Byte 3	Byte 4
A7	40	A0	F5

Figure 12: Serial Mux Header Token

COMMAND TYPES

Figure 13 shows the command types that are specific to Serial Mux and Figure 14 shows the response codes. All other command types, byte ordering and transmission order for the headers and command structures are described in the Linear Tech SmartMesh IP Embedded Manager API Guide.

Command Name	Type	Description
Hello	1	Serial Mux client hello message.
Serial Mux Version	2	Get Serial Mux information.

Figure 13: Command Types

RESPONSE CODES

Response Code	Value	Description
OK	0	The command executed without error.
Invalid Command	1	The specified command type is invalid.
Invalid Argument	2	A command argument is invalid.
Invalid Authentication	3	The Hello message contains an invalid authentication token.
Unsupported Version	4	The Hello message contains an unsupported version.
Command Timeout	5	The Command response from the manager timed out.

Figure 14: Serial Mux Response Codes

CONNECTION HANDSHAKE

The Serial Mux listens for TCP connections from clients on a configurable TCP port.[2] When the client connects to the Serial Mux, the Serial Mux expects to receive a Hello message before any other commands are sent.

SERIAL MUX HELLO REQUEST

Parameter	Type	Description
Version	INT8U	SmartMesh IP client protocol version.
Authentication	INT8U[8]	Authentication secret.

Figure 15: Serial Mux Hello Message Request Payload

To send a Hello to the Serial Mux, the client establishes a TCP connection to the Serial Mux and sends the following byte stream.

Header Token	Length	Reserved	Hello Command	Hello Version	Hello Authentication
A7 40 A0 F5	00 0C	00 00	01	04	30 31 32 33 34 35 36 37

Figure 16: Serial Mux Hello Message Request Example

[2] The TCP connection is not encrypted, so it is recommended to use Serial Mux over a VPN.

SERIAL MUX HELLO REPLY

Parameter	Type	Description
rc	INT8U	Response Code
version	INT8U	SmartMesh IP Manager protocol version.

Figure 17: Serial Mux Hello Message Response Payload

When the sent authentication token matches the Serial Mux authentication token, the Serial Mux will respond with:

Header Token	Length	Reserved	Hello Reply	Response Code	Hello Response Version
A7 40 A0 F5	00 05	00 00	01	00	04

Figure 18: Serial Mux Hello Message Response Example

SERIAL MUX INFO

SERIAL MUX INFO REQUEST

The Serial Mux Info command is provided to allow clients to query the Serial Mux version. There are no parameters to the info command.

Header Token	Length	Reserved	Info Command
A7 40 A0 F5	00 03	00 00	02

Figure 19: Serial Mux Info Message Example

SERIAL MUX INFO REPLY

Parameter	Type	Description
protocolVersion	INT8U	Manager Serial API version.
majorVersion	INT8U	Serial Mux major version.
minorVersion	INT8U	Serial Mux minor version.
releaseVersion	INT8U	Serial Mux release version.
buildVersion	INT16U	Serial Mux build number.

Figure 20: Serial Mux Info Message Request Payload

Header Token	Length	Reserved	Info Reply	Protocol Version	Major Version	Minor Version	Release Version	Build Version
A7 40 A0 F5	00 09	00 00	02	04	01	02	02	00 00

Figure 21: Serial Mux Hello Message Response Example

EXAMPLE COMMAND

EXAMPLE REQUEST

The GetNetworkInfo command can be sent by:

Header Token	Length	Reserved	Command Type
A7 40 A0 F5	00 04	00 00	04

Figure 22: Serial Mux Command Request Example

EXAMPLE REPLY

The Serial Mux responds with:

Header Token	Length	Reserved	Command Type	Response Code	GetNetworkInfo Response
A7 40 A0 F5	00 0C	00 00	01	04	00 00 02 1C 52 00 01 64 48 00 00 08 FC 00 F4 80 00 00 00 00 00 00 00 17 0d 00 00 30 01 C7

Figure 23: Serial Mux Command Response Example

SUBSCRIPTION AND NOTIFICATION

The Serial Mux allows clients to subscribe to notifications from the manager using the same subscribe command provided by the Serial API. In the subscribe request, the client lists the types of notifications that it wishes to receive. Several clients may be subscribed for the same types of notifications. The Serial Mux serializes and sends notifications for each client on the client's TCP connection. The client may see notification messages interleaved with command responses. The Serial Mux acknowledges notifications to the manager and handles the complexity of managing different notifications for different clients.

DISCONNECTION

The Serial Mux maintains a timer while waiting for a command response. If the timer expires, then Serial Mux:

- resets the Manager connection
- closes all connected clients
- tries to reconnect to the Manager by sending a Serial API Hello message

When the Serial Mux cannot write to a client’s connection, the connection is closed.

ADDITIONAL RESOURCES

SmartMesh IP Tools Guide: http://www.linear.com/docs/42453

SmartMesh IP Embedded Manager API Guide: http://www.linear.com/docs/41883

SmartMeshSDK-full-10.4.110.zip: http://www.linear.com/docs/43297

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