mangOH™ Green

Tutorial—Wi-Fi Expansion Card

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Contents

1: Getting Started

This tutorial will take you through the process of adding a Wi-Fi Expansion Card to your mangOH Green, preparing your target for use with sample Wi-Fi applications, and operating it as a Wi-Fi client device or Wi-Fi gateway (access point).

The tutorial builds on basics covered in the mangOH Green Fundamentals tutorial, available at http://mangoh.io/getting-started.

To work through this tutorial, you will need:

- mangOH Green hardware, set up as described in the mangOH Green Fundamentals tutorial.
- Application that can open a SSH connection to the mangOH Green. For example, puTTY.
- (Optional) Legato Developer Studio for some tasks. Instructions are provided for both command line interfaces and the Developer Studio.
- Ethernet (RJ-45) cable
- Ethernet gateway
- Wi-Fi-enabled device (smartphone, PC, etc.) to test the Wi-Fi client and access point modes.

The sample applications that are used in this tutorial do not require any modifications, but if you want to experiment with them, you will need to have the Legato development environment (CLI or Developer Studio) installed on your Windows or Linux computer. See the mangOH Green Fundamentals tutorial for details.

This tutorial includes:

Important: *To get maximum benefit from this tutorial, you are strongly recommended to carefully follow the procedures as described, since the tutorial continually builds on earlier procedures and results. If you skip steps or use alternate methods, you may encounter difficulty completing the tutorial.*

Tip: *If you have only one monitor, you may want to print this document and use it when you don't want to switch back and forth between the PDF and the various windows/applications you'll be opening during the tutorial.*

2: Before you begin

Before you begin the tutorial, here are a few items that you might find helpful:

- A few terms:
  - "WP"—The mangOH Green supports CF3 (Common Form Factor) embedded modules, such as the WP8548.
    Throughout this tutorial,"WP" is used to refer to the module that comes with your mangOH Green kit.
  - In this tutorial, the 'host' is your computer, and the 'target' is the WP module in your mangOH Green.
- Some symbols used in this document:
  - Shell (console) commands are shown with a symbol before the command:
    - '$'—Command is entered on the Linux computer or Virtual Machine
    - '#'—Command is entered on the target (the WP module in your mangOH Green)
    - '>'—Command is entered on the Windows host (your computer)
  - '~' and "$HOME" both represent your 'home directory' in Linux
- Passwords, etc:
  - WP module:
    - USB ECM IP address—192.168.2.2
    - User name—root
    - Password—<none>

3: Set up your mangOH Green

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In this section, you will learn how to connect a Wi-Fi Expansion Card to the mangOH Green, make sure the target's embedded software (firmware and framework) are up to date, and verify that appropriate Wi-Fi applications are running on the target.

For this tutorial, you need the following materials:

- mangOH Green with (at least):
  - Main antenna connected
  - Activated SIM inserted
  - Power supplied via USB or the DC jack

Note: The mangOH Green Fundamentals tutorial (available at http://mangoh.io/getting-started) describes the basic device setup.

- Wi-Fi Expansion Card
  (You do not need an external Wi-Fi antenna—the Wi-Fi Expansion Card has ceramic SMD 2.4 GHz Wi-Fi antennas pre-mounted.)

To set up the mangOH Green for use with the Wi-Fi Expansion Card:

1. Make sure your mangOH Green is set up with (at least) an activated SIM, the main antenna, and USB or DC power selected.

2. Make sure power is not being supplied (unplug the micro-USB cable or DC power adapter).

3. Insert the Wi-Fi Expansion Card into slot IOT0. Slide the expansion card into the rails until it meets the IoT Connector, then press firmly to seat the expansion card into the connector.

Important: *You **must** use slot IOT0 for the expansion card. The card will not work in IOT1 or IOT2.*

4. Connect the power to the mangOH Green (micro-USB or DC).

5. Wait until the mangOH Green boots, then check the version numbers of the firmware and Legato framework running on the target to see if they meet the minimum requirements for the Wi-Fi expansion card:

    Command Line procedure:

    a. In a terminal window, connect to the target's console:

    ```
    $ ssh root@192.168.2.2
    ```

    b. Check the target's firmware version:

    ```
    # fwupdate query
    ```

    ```
    root@swi-mdm9x15:~# fwupdate query
    Connecting to service ...
    Firmware Version: SWI9X15Y 07.10.04.00 r32393 CARM
    Bootloader Version: SWI9X15Y_07.10.04.00 r32393 CA
    Linux Version: 3.14.29ltsi-c14b887744_39dcf2256d #
    ```

    c. Check the target's Legato framework version:

    ```
    # legato version
    ```

    ```
    root@swi-mdm9x15:~# legato version
    16.04.0 63633d9200de787b7c2a6dca03d2cff3
    ```

    Developer Studio procedure:

    a. In the Remote System view, expand the connection name and click Legato Framework.

Property	Value
Bootloader version	SWI9X15Y_07.10.04.00 r32393 CARMD-EV-FRMWR1 2016/06/01 20:30:40
CPU count	1
IMEI	359377060009510
Legato firmware version	SWI9X15Y 07.10.04.00 r32393 CARMD-EV-FRMWR1 2016/06/01 20:30:40
Legato framework status	Running
Legato framework version	16.04.0 53633d9200de787b7c2a6dca03d2cff3
Legato module	WP85XX
Linux hostname	swi-mdm9x15
Linux version	3.14.29ltsi-c14b887744_39dcf2256d #2 PREEMPT Wed Jun 1 23:37:34 PDT
Modem package ID	1102621_9904889_WP8548_07.10.04.00_00_Generic_001.008_000
Serial number	LL542500031203

    b. In the Properties tab (in the Remote System view), check the Legato firmware version and Legato framework version.

6. If the firmware version is lower than 07.10.04.00 and/or the Legato framework version is lower than 16.04.0, you must upgrade your WP module to support the Wi-Fi expansion card:

   a. Go to http://source.sierrawireless.com/resources/legato/wpfirmwarerelease/.

   b. Download the customer configuration file (Windows EXE, or Linux Binaries) for your module type.

   c. Download the carrier configuration file (Windows EXE, or Linux Binaries).

   d. Follow the upgrade instructions procedure for Windows or Linux to upgrade your module.

7. Make sure the wifiService application is running on the target, and all other Wi-Fi applications are stopped (by default, when the mangOH Green boots, only wiFiService will be running).

   The applications to check are:

   - wifiService—Implements Wi-Fi Client and Access Point services.
   - wifi—Command line selection and control of Wi-Fi Client mode and Wi-Fi Access Point mode. The framework automatically starts/stops the application when needed. Do not start or stop it manually.
   - wifiClientTest—Sample application that demonstrates Wi-Fi client mode (not used in this tutorial)
   - wifiApTest—Sample application that creates a Wi-Fi/Ethernet gateway (Access Point mode)
   - wifiWebAp—Sample application that creates a Wi-Fi/Cellular gateway (Access Point mode). The application includes a web setup page to configure the Wi-Fi network and gateway (SSID, DHCP server IP addresses, etc.)

   Command Line procedure:

   a. In the terminal window connected to the target's console, list the applications and their current status:

   ```
   # app status
   ```


   wifiService should be 'running', all others should be 'stopped'

b. If any of the other Wi-Fi apps are running (wifiApTest, wifiClientTest, wifiWebAp), stop them. Replace "<appname>" with the application being stopped:

```
# app stop <appname>
```

Developer Studio procedure:

a. In the Remote System view, expand (click) Application Manager:
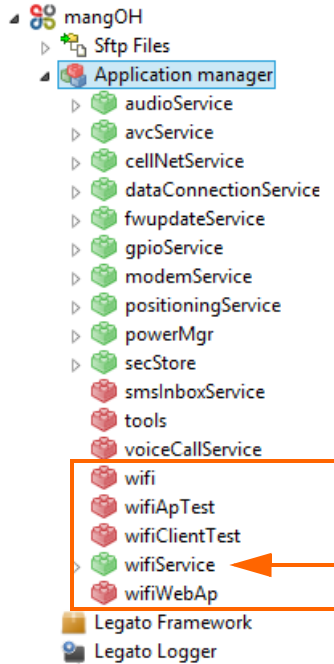

wifiService should be 'running' (green), all others should be 'stopped' (red)

b. If any of the other Wi-Fi apps are running (wifiApTest, wifiClientTest, wifiWebAp), stop them—Right-click the application name, then select Stop.

Now you are ready to Connect mangOH Green to a Wi-Fi network on page 11.

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Wi-Fi/
Ethernet
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Gateway

4: Connect mangOH Green to a Wi-Fi network

4

In this section, you will learn how to configure your mangOH Green to connect to a Wi-Fi network in Wi-Fi client mode.

To connect your mangOH Green as a Wi-Fi client:

1. Connect to the target:

    Command Line procedure:

    a. In a terminal window, connect to the target's console:

    ```
    $ ssh root@192.168.2.2
    ```

    Developer Studio procedure:

    a. In the Remote System view, right-click the connection to the target, and select Open SSH Terminal.
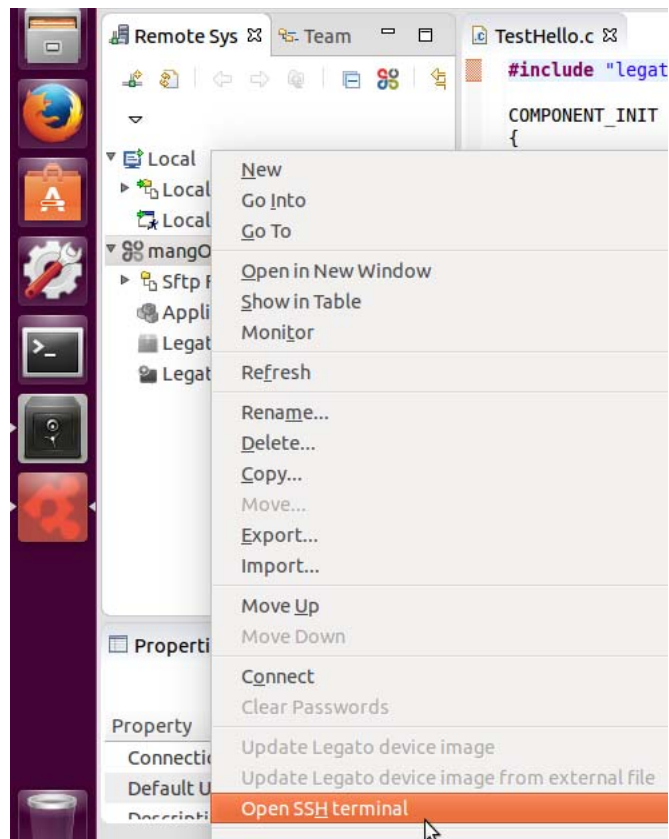
    b. When the Launch Terminal window opens, make sure the Host field is 192.168.2.2 and the User is root.

    c. Click OK. The terminal connection appears in the Terminal view.

2. Start Wi-Fi Client mode.

    ```
    # wifi client start
    ```


    ```
    root@swi-mdm9x15:~# wifi client start
    successfully called start
    ```

    The Wi-Fi LED on the Wi-Fi expansion card turns ON.

3. Perform a Wi-Fi scan to discover available Wi-Fi hotspots.

```
# wifi client scan
```

```
root@swi-mdm9x15:~# wifi client scan
starting scan
Found:  SSID:   "SWI-WLAN"      Strength:-91    Ref:0x10000003
Found:  SSID:   "Test"  Strength:-91    Ref:0x10000001
Found:  SSID:   "myhomewifi"    Strength:-69    Ref:0x10000009
Found:  SSID:   "SWI-MOBILE"    Strength:-91    Ref:0x10000007
Found:  SSID:   "SWI-GUEST"     Strength:-78    Ref:0x10000005
```

4. Connect to an available hotspot for which you have the required credentials. For example, the "myhomewifi" hotspot shown in the Wi-Fi scan above will be used with the following settings:
   - SSID: "myhomewifi"
   - Passphrase: "myhomepassphrase"
   - Security protocol: WPA2 Personal Security mode

   a. Set the security protocol, replacing "<ref>" and "<protocol>" with:
      - <ref> = 'Ref' number listed for the hotspot in the scan result above

      - <protocol> = Security protocol:
         - 0: No security
         - 1: WEP security mode
         - 2: WPA Personal security mode
         - 3: WPA2 Personal security mode
         - 4: WPA Enterprise security mode
         - 5: WPA2 Enterprise security mode

   ```
   # wifi client setsecurityproto 0x10000009 3
   ```

   ```
   root@swi-mdm9x15:~# wifi client setsecurityproto 0x10000009 3
   wifi client le_wifiClient_SetSecurityProtocol  0x10000009
   Successfully set security protocol
   ```

   b. Set the passphrase:

   ```
   # wifi client setpassphrase 0x10000009 myhomepassphrase
   ```

   ```
   root@swi-mdm9x15:~# wifi client setpassphrase 0x10000009 myhomepassphrase
   le_wifiClient_SetPassphrase returns OK
   ```

   c. Connect to the Wi-Fi hotspot in client mode:

   ```
   # wifi client connect 0x10000009
   ```

   ```
   root@swi-mdm9x15:~# wifi client connect 0x10000009
   Connecting
   CONNECTED
   ```

5. Connect to the Internet—If the mangOH Green is connected to an Ethernet gateway that has Internet access and implements a DHCP server, you can test the Internet connection by pinging a remote server:

   a. Get an IP address from the Ethernet gateway (send a DHCP client request):

   ```
   # /sbin/udhcpc -R -b -i wlan0
   ```

   ```
   root@swi-mdm9x15:~# /sbin/udhcpc -R -b -i wlan0
   udhcpc (v1.22.1) started
   Sending discover...
   Sending select for 192.168.40.218...
   Lease of 192.168.40.218 obtained, lease time 28800
   /etc/udhcpc.d/50default: Adding DNS 8.8.8.8
   /etc/udhcpc.d/50default: Adding DNS 4.2.2.2
   ```

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b. Check the target's Wi-Fi connection to the Internet by pinging a URL that you know is working:

```
# ping mangoh.io
```

```
root@swi-mdm9x15:~# ping mangoh.io
PING mangoh.io (185.31.17.133): 56 data bytes
64 bytes from 185.31.17.133: seq=0 ttl=49 time=690.402 ms
64 bytes from 185.31.17.133: seq=1 ttl=49 time=303.433 ms
64 bytes from 185.31.17.133: seq=2 ttl=49 time=218.282 ms
64 bytes from 185.31.17.133: seq=3 ttl=49 time=132.214 ms
64 bytes from 185.31.17.133: seq=4 ttl=49 time=159.683 ms
64 bytes from 185.31.17.133: seq=5 ttl=49 time=114.665 ms
^C
--- mangoh.io ping statistics ---
6 packets transmitted, 6 packets received, 0% packet loss
round-trip min/avg/max = 114.665/269.779/690.402 ms
root@swi-mdm9x15:~#
```

Note: To stop the ping responses, press Ctrl+C.

6. Stop Wi-Fi Client mode:

```
# wifi client stop
```

```
root@swi-mdm9x15:~# wifi client stop
le_wifiClient_Stop returns OK
```

The Wi-Fi LED on the Wi-Fi expansion card turns OFF.

You have successfully used the Wi-Fi expansion card as a Wi-Fi client to access the Internet from the target.

Now you are ready to Create a Wi-Fi/Ethernet Gateway on page 14.

5: Create a Wi-Fi/Ethernet Gateway

5

In this section, you will learn how to configure your mangOH Green as a Wi-Fi/ Ethernet gateway.

This part of the tutorial requires the following equipment:

- Ethernet local network equipped with a gateway device that provides Internet access and acts as a DHCP server.
- A Wi-Fi enabled device (smartphone, PC, etc.)

This procedure uses the wifiApTest sample Legato application, which uses the Wi-Fi Access Point API to implement a Wi-Fi/Ethernet gateway that provides Wi-Fi services and DHCP server functionality (to provide IP addresses). The application creates the following Wi-Fi access point:

- AP name: wifiApSSID
- Mode: WPA2 Personal Security
- Passphrase: passphrase

Note: The Wi-Fi gateway also implements DHCP server functionality to provide IP addresses, although this is not a part of the wifiService.

To create and test the Wi-Fi/Ethernet gateway:

1. Connect your mangOH Green to your local Ethernet network (e.g. via your Ethernet gateway device) with an RJ-45 cable. The sample application will bridge the Ethernet and the Wi-Fi AP's IP.

Important: *Do not try to run the wifiApTest and wifiWebAp applications at the same time. They will not work properly.*

2. Start the wifiApTest sample application:

   Command Line procedure:
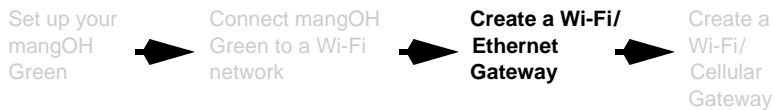
   a. In a terminal window, connect to the target's console:

   ```
   $ ssh root@192.168.2.2
   ```

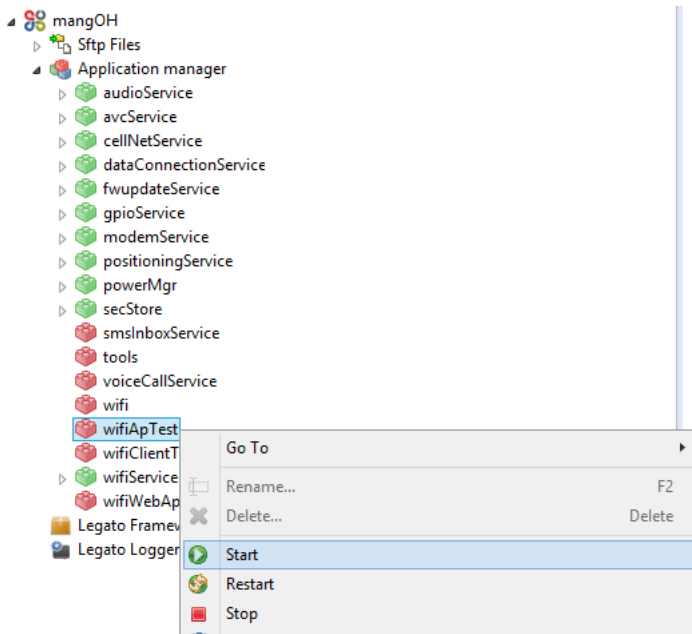   b. Start the sample application:

   ```
   # app start wifiApTest
   ```

   ```
   root@swi-mdm9x15:~# app start wifiApTest
   Starting app 'wifiApTest'...
   DONE
   ```

Developer Studio procedure:

a. In the Remote System view, expand the connection name > Application Manager to see the applications and services that are currently running on the target. "wifiApTest" will appear in the list.
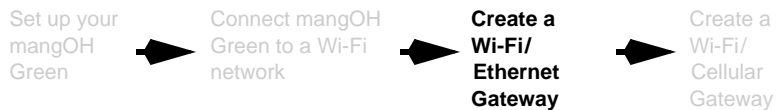

b. Right-click wifiApTest and select Start.
The Wi-Fi LED on the Wi-Fi expansion card turns ON.

3. On a Wi-Fi-enabled device (smartphone, PC, etc.), scan for available hotspots. You should see a hotspot named "wifiApSSID".

4. Connect your device to the hotspot using the passphrase "passphrase". The application provides your device with an IP address, and your device will now be able to connect to the Internet via the hotspot and gateway device.

5. Test the hotspot connection by using your device to browse the Internet.

6. When finished testing the connection, stop the sample application:

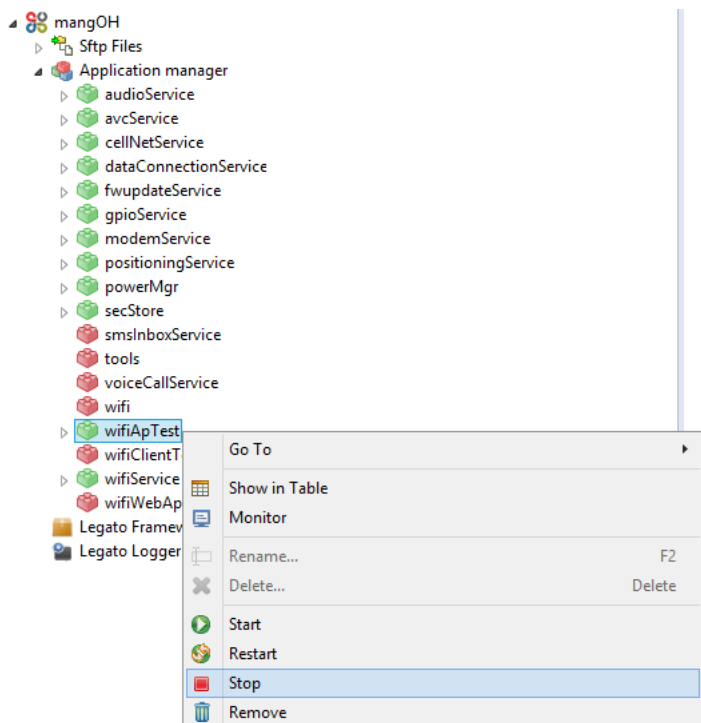**Command Line procedure:**

a. Stop the sample application:

```
# app stop wifiApTest
```

```
root@swi-mdm9x15:~# app stop wifiApTest
Stopping app 'wifiApTest'...
DONE
```

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Developer Studio procedure:

a. In the Remote System view, expand the connection name > Application
Manager.

b. Right-click wifiApTest and select Stop.

Note: The Wi-Fi LED on the Wi-Fi expansion card turns OFF.

You have successfully used the Wi-Fi expansion card to create an access point over
an Ethernet connection. The expansion card can also be used to Create a Wi-Fi/
Cellular Gateway on page 17.

6: Create a Wi-Fi/Cellular Gateway

6

In this section, you will learn how to configure your mangOH Green as a Wi-Fi/ Cellular gateway.

This part of the tutorial requires the following equipment:

- mangOH Green with an activated SIM card (with data subscription) installed as described in the mangOH Green Fundamentals tutorial ("Connect to Mobile Networks" chapter).
- Firefox or Chrome browser on your host computer to configure the access point. Internet Explorer will not work properly.
- A Wi-Fi enabled device (smartphone, PC, etc.)

This procedure uses the wifiWebAp sample Legato application, which uses the Wi-Fi Access Point API to implement a Wi-Fi/Cellular gateway that provides Wi-Fi services and DHCP server functionality (to provide IP addresses).

The application creates the following Wi-Fi access point:

- AP name: wifiWebApSSID
- Mode: WPA2 Personal Security
- Passphrase: passphrase

The application also implements a simple web server to configure some of the Wi-Fi Access Point parameters.

Note: The Wi-Fi gateway also implements DHCP server functionality to provide IP addresses, although this is not a part of the wifiService.

Important: *Do not try to run the wifiApTest and wifiWebAp applications at the same time. They will not work properly.*

To create and test the Wi-Fi/Cellular gateway:

1. Start the wifiWebAp sample application:

    Command Line procedure:

    a. In a terminal window, connect to the target's console:

    ```
    $ ssh root@192.168.2.2
    ```

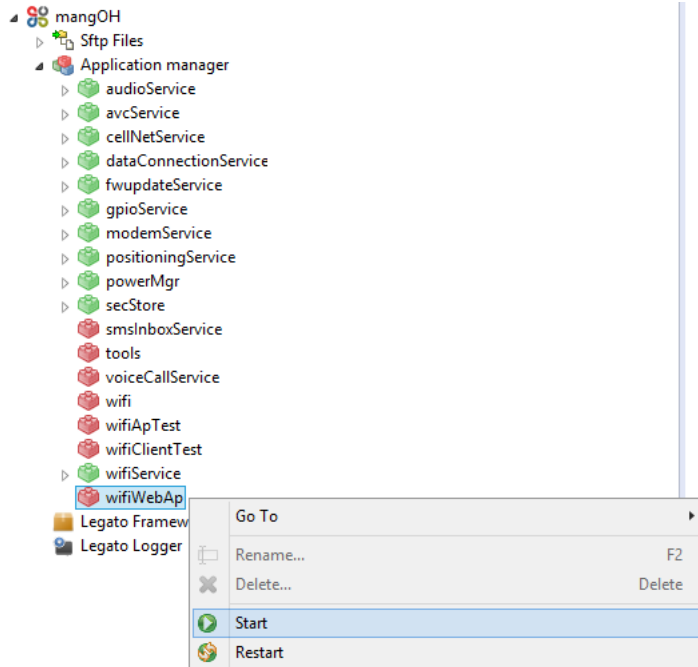   b. Start the sample application:

    ```
    # app start wifiWebAp
    ```

    ```
    root@swi-mdm9x15:~# app start wifiWebAp
    Starting app 'wifiWebAp'...
    DONE
    ```

Developer Studio procedure:

a. In the Remote System view, expand the connection name > Application Manager to see the applications and services that are currently running on the target. "wifiWebAp" will appear in the list.

b. Right-click wifiWebAp and select Start.
   The Wi-Fi LED on the Wi-Fi expansion card turns ON.

2. On your host computer, launch Firefox or Chrome and connect to 192.168.2.2:8080 to display the Wi-Fi Access Point setup page.
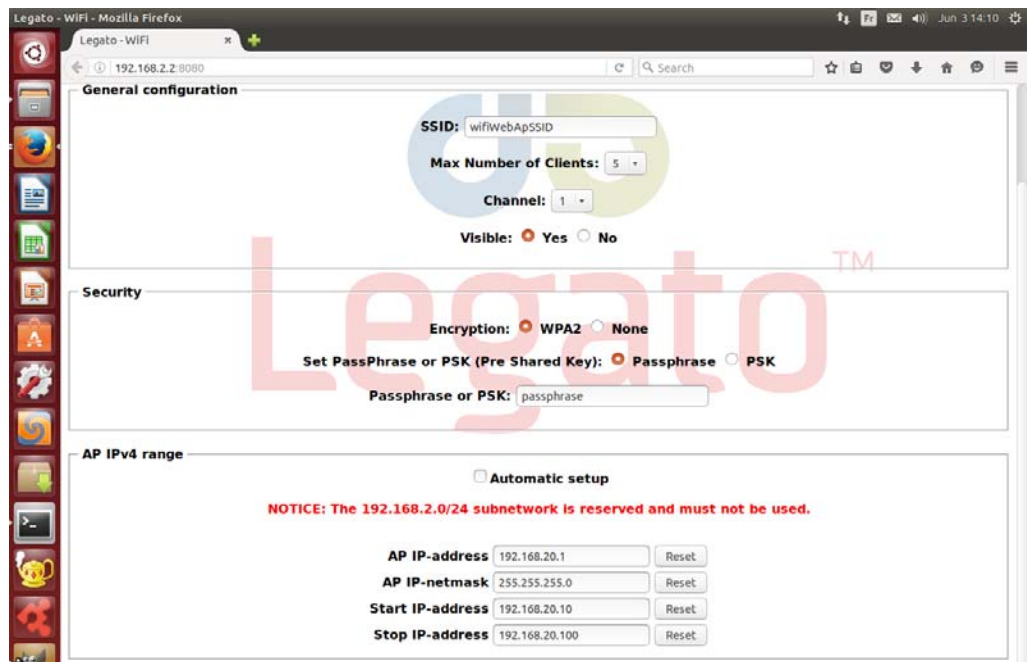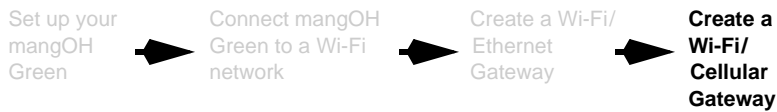
3. If desired, modify the default access point settings.
    Note the following conditions:
    · If you want to reset any IP address fields to their default values, click the corresponding Reset buttons.
    · Make sure the setting you choose is valid. For example, do not enter a Stop IP-address that is lower than the Start IP-address.
    · Do not use the IP address range 192.168.2.000–192.168.2.255. This range is reserved for the USB interface and will not work for the access point.

Note: The default configuration will work without making any changes.

---

4. Click Start Wifi AP.
    The Logs section displays status messages as the Access Point starts up. After the "Waiting for connections..." message appears, you will see messages each time a device connects/disconnects from the AP.
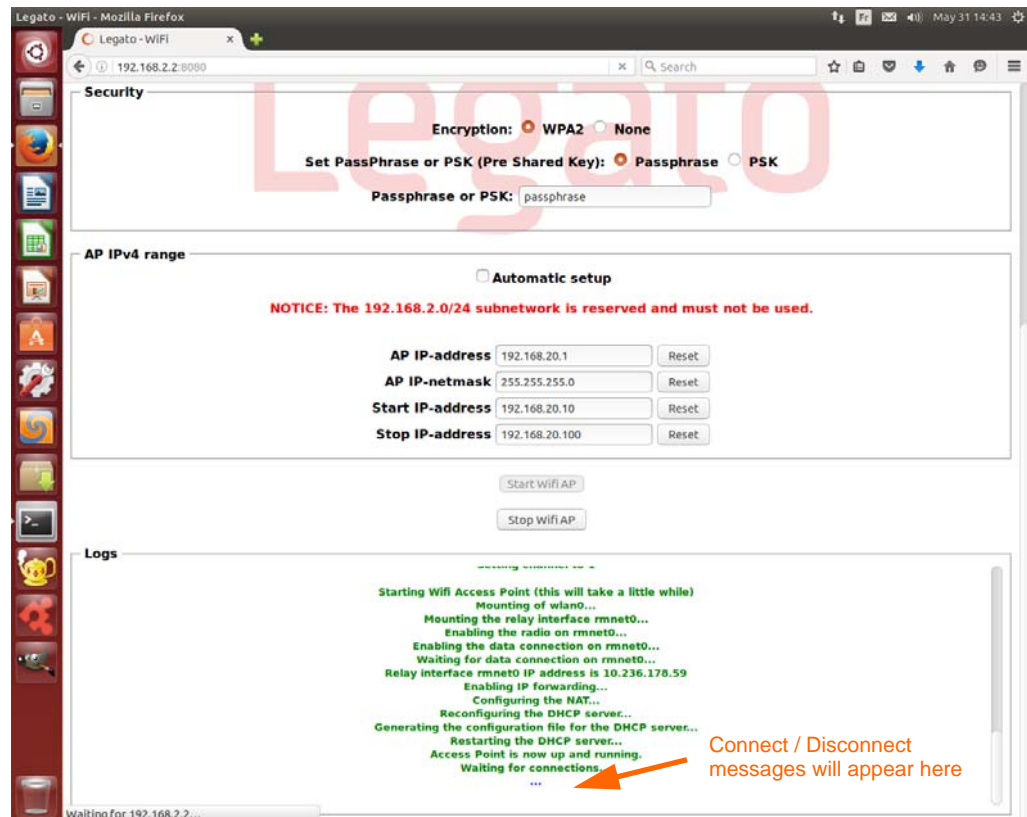
5. On a Wi-Fi-enabled device (smartphone, PC, etc.), scan for available hotspots. You should see a hotspot with the SSID that you entered in the General configuration section of the setup page. (In this example, the SSID is wifiWebApSSID.)

6. Connect your device to the hotspot using the passphrase that you entered in the Security section of the setup page. (In this example, the passphrase is "passphrase".)

    The application provides your device with an IP address, and your device will now be able to connect to the Internet via the hotspot and gateway device.
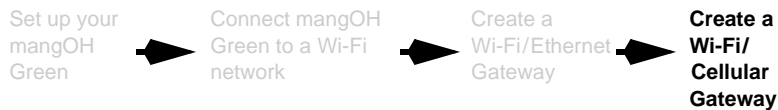
7. Test the hotspot connection by using your device to browse the Internet.
8. When finished testing the connection, stop the sample application:
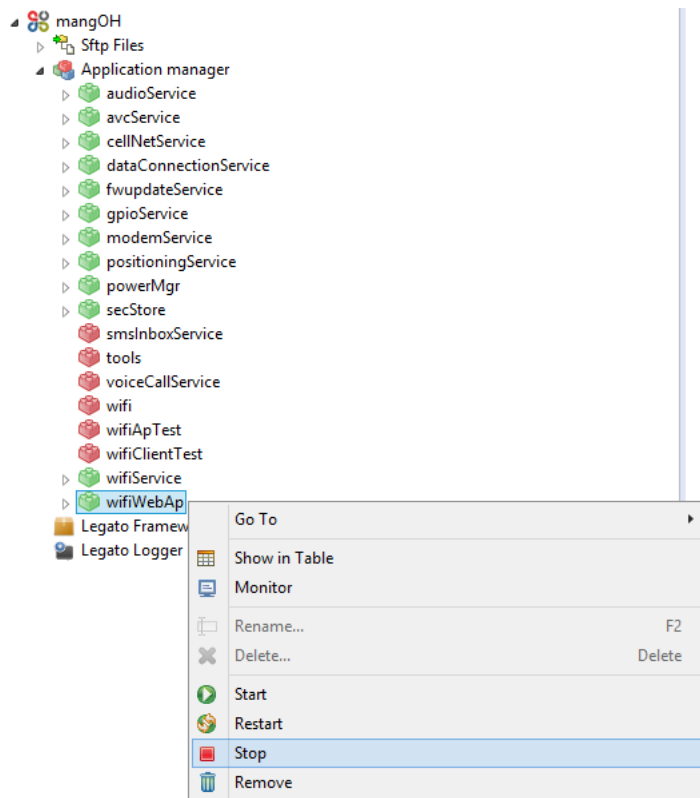
Command Line procedure:

a. Stop the sample application:

```
# app stop wifiWebAp
```

```
root@swi-mdm9x15:~# app stop wifiWebAp
Stopping app 'wifiWebAp'...
DONE
```

Developer Studio procedure:

a. In the Remote System view, expand the connection name > Application Manager.

b. Right-click wifiApTest and select Stop.
The Wi-Fi LED on the Wi-Fi expansion card turns OFF.

You have successfully used the Wi-Fi expansion card to create an access point over a cellular connection, and completed the mangOH Green Wi-Fi Expansion Card tutorial.

For more information on the mangOH platform, visit http://mangoh.io.

A: Tips

A

A.1 Finding your SIM's APN

Your SIM provider should give you the APN that you use to connect to their network. If you don't have the APN, you should be able to find it online.

Common APNs:
- Rogers Wireless—"internet.com"
- Others—Search the Internet for "<provider> APN". For example, "Rogers Wirelesss APN"

A.2 Using the Linux Terminal program

Ubuntu includes a terminal emulator, which is labeled as "Terminal" in the desktop environment. The emulator allows you to execute command-line programs that interact with the Legato framework tools on your computer and the WP module in the mangOH Green.

For this tutorial, here are some useful tips:

- Open a terminal window. In the Unity desktop shell used by default on Ubuntu Linux, do this using either of these methods:
  - Click the Search icon and type "terminal", then run the application that is listed.
  - Press Ctrl+Alt+T
- Open a new tab in a window—Press Ctrl+Shift+T
- Change a tab name in a window—Right-click in the tab and select Set Title.
- Copy text from a window—Highlight the text and press Ctrl+Insert.
- Paste text into a window—Press Shift+Insert.
- For in-depth detail, refer to https://help.ubuntu.com/community/UsingTheTerminal.

A.3 Useful Linux commands for this tutorial (and more)

The following table describes the Linux commands you will use in this tutorial, plus other useful commands.

For more details and command options, see http://legato.io/legato-docs/latest/toolsTarget.html.

Table A-1: Linux commands

Command types	Command	Description
Versioning	cm info	Display the modules model, IMEI, FSN (serial number), and firmware and bootloader versions.
	legato version	Display the Legato framework version.
Radio	cm radio	Display the radio status.
	cm radio on cm radio off	Enable or disable the radio.
	Refer to cm radio (http://www.legato.io/legato-docs/latest/tools_target_cm.html) for more details and command options.	
Data connections	cm data cm data info	Display information about the current profile in use.
	cm data apn <yourAPN>	Set the APN for your profile to the APN from your SIM provider.
	cm data connect	Start a data connection.
	cm data connect <timeout>	Start a data connection (keep trying for up to <timeout> seconds).
	Refer to cm data (http://www.legato.io/legato-docs/latest/tools_target_cm.html) for more details and command options.	
SIM	cm sim info	Display information about the SIM.
	cm sim status	Display the SIM status
	cm sim enterpin	Enter a SIM PIN code to be able to use the SIM.
	Refer to cm sim (http://www.legato.io/legato-docs/latest/tools_target_cm.html) for more details and command options.	
Applications	app status	Display the status of installed applications (running, stopped).
	app start <appName> app stop <appName> app remove <appName>	Start, stop, or remove an application.
	Refer to app (http://www.legato.io/legato-docs/latest/tools_target_app.html) for more details and command options.	

Table A-1: Linux commands (Continued)

Command types	Command	Description
Wi-Fi	wifi client <options>	Commands to start, stop, and configure the Wi-Fi client.
	wifi client help	Display options and instructions for configuring the Wi-Fi client.
	wifi ap <options>	Commands to start, stop, and configure the Wi-Fi access point.
	wifi ap help	Display options and instructions for configuring the Wi-Fi access point.
	lfup wlan0 lfdown wlan0	Bring up or take down the Wi-Fi interface. *Note: Do not use ifconfig wlan0 up/down to control the Wi-Fi interface.*