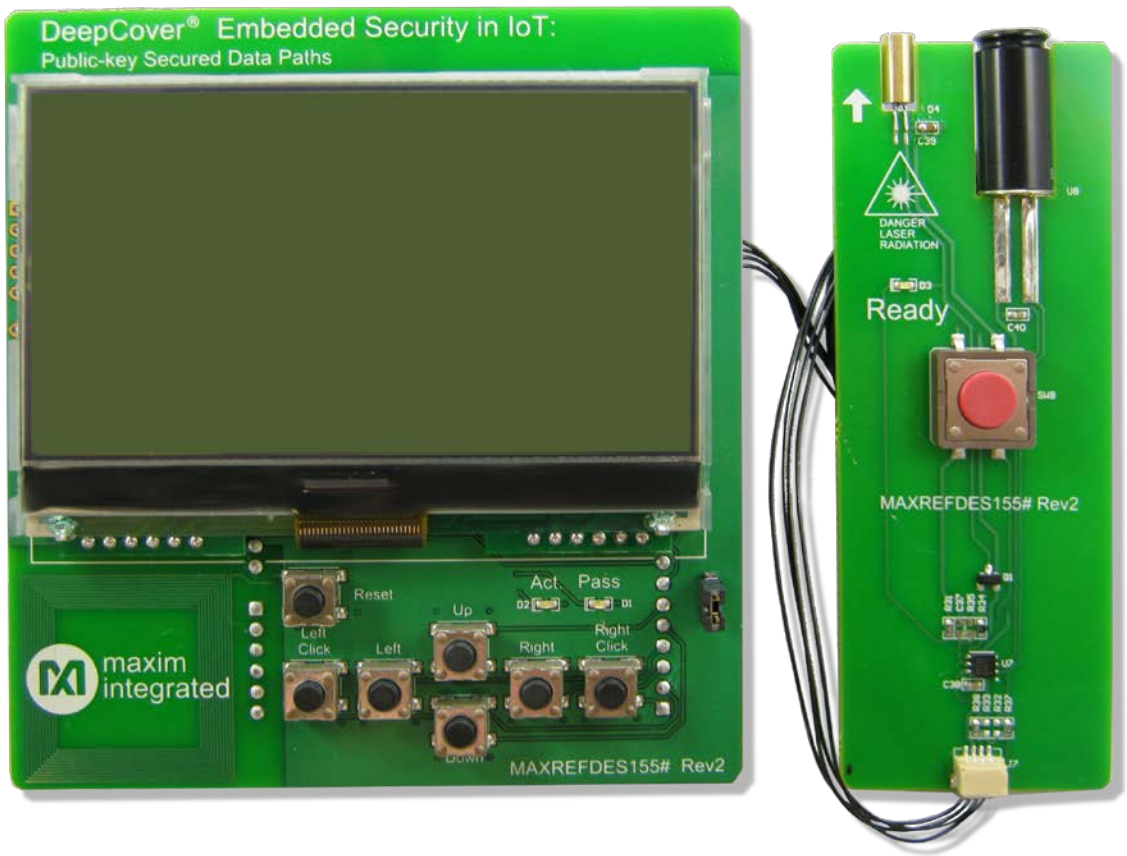
MAXREFDES155# DeepCover Embedded Security in IoT: Public-key Secured Data Paths Quick Start Guide

UG6389; Rev 2; 5/17



Abstract

This Quick Start Guide provides information about preparing and running the MAXREFDES155# ARM® mbed™ example and web client. The MAXREFDES155# subsystem reference design secures an authenticated data link between IoT devices and the web using the DS2476 DeepCover® secure coprocessor.

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Required Equipment

The equipment, ARM® mbed™ shield (MAXREDES155#) and mbed base board (MAX32600MBED#), are available for separate purchase at Maxim Integrated's website to produce the hardware needed for the mbed system. Here is the list of the equipment required:

- MAXREFDES155# kit including:
  - MAXREFDES155# mbed shield.
  - Infrared (IR) laser-sensor module.
  - 30.48cm long x 1mm pitch SR Cable (A04SR04SR30K305B).
- MAX32600MBED# base board.
- Wi-Fi Hotspot (internet access is needed for MAXREFDES155#)
- USB A to USB micro-B cable
- Internet-connected computer with USB-to-load firmware.

Import Firmware

1. Load the mbed repository page for the "MAXREFDES155" firmware program in your web browser.

    a. Go to the mbed web page located at https://developer.mbed.org.

    b. In the upper-right corner use the **Search mbed...** box type the text string "MAXREFDES155" and hit the enter key to initiate the search.

    c. Click on the top search result that begins with "MAXREFDES155."

2. Import the latest revision of the program into the online compiler by clicking on the **Import into Compiler** button in the mbed repository page (**Figure 1**). A free mbed account is required to access the online compiler.

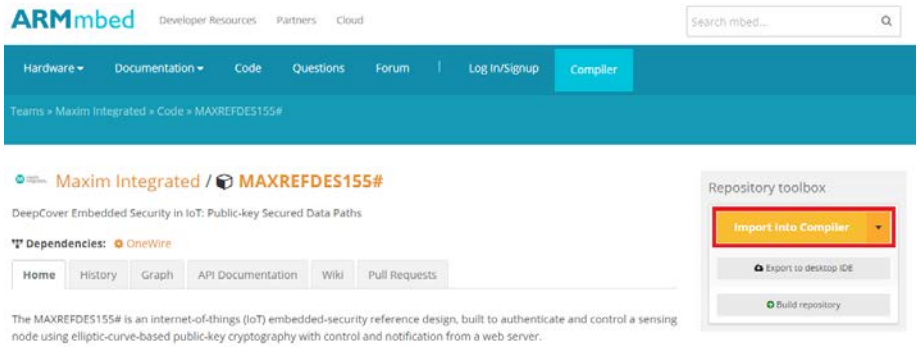

*Figure 1. **Import into Compiler** button.*

Load Firmware

1. Add the MAX32600MBED platform to your compiler by clicking the **Add to your mbed Compiler** button at the top right side of the MAX32600MBED platform page (**Figure 2**).

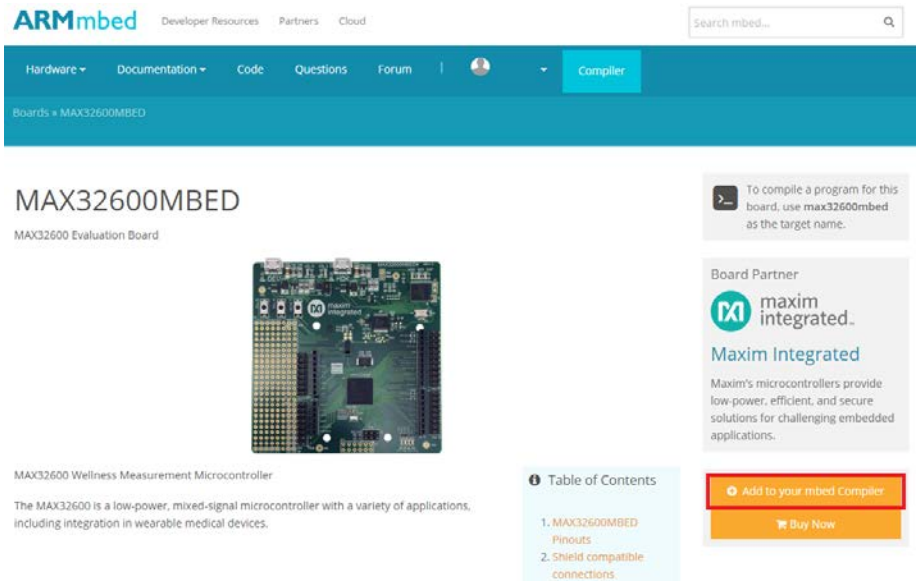

*Figure 2. **Add to your mbed Compiler** button.*

2. Return to the online compiler page, and select the MAX32600MBED as the compiler target by the following steps in **Figure 3**:

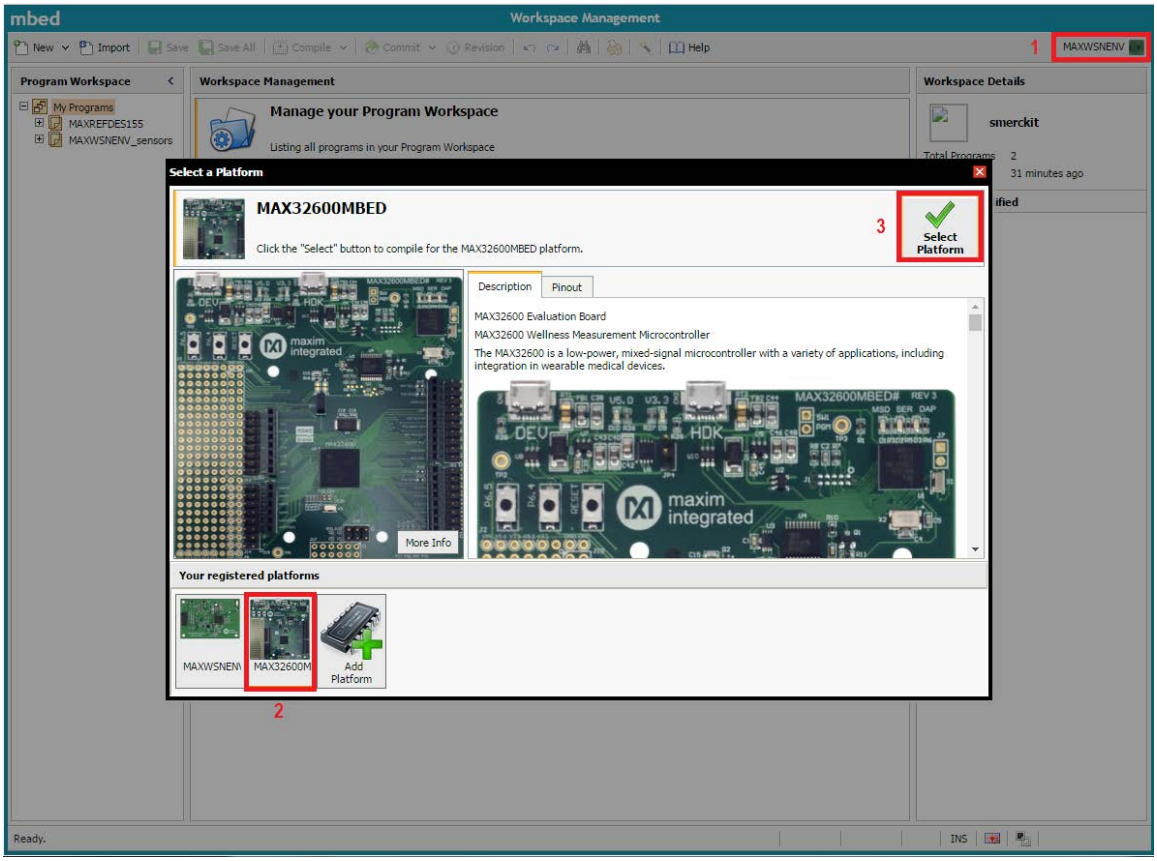

Figure 3. Selecting the MAX32600MBED as the compiler target.

3. Open the source file **WifiConnectWindow.cpp** in the imported copy of **MAXREFDES155** (**Figure 4**).

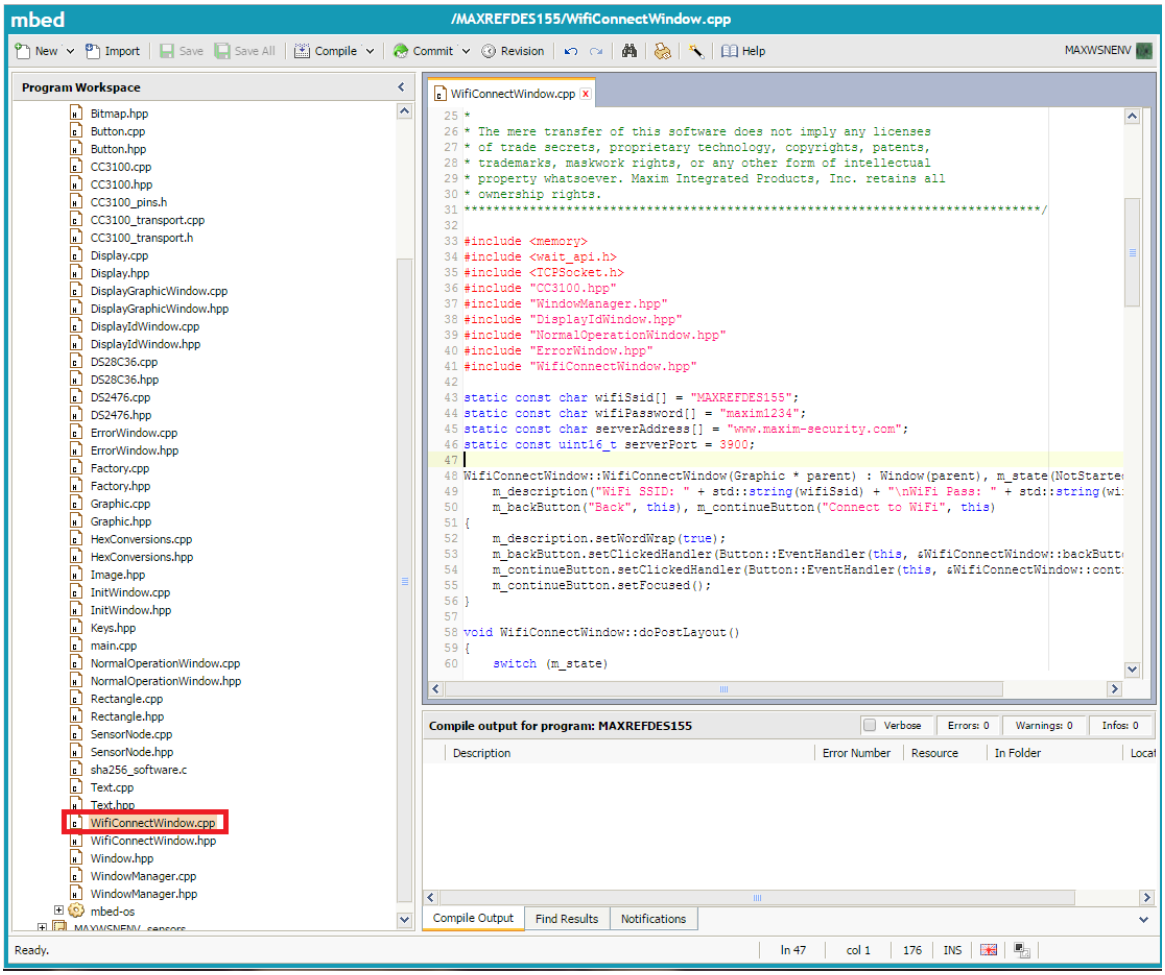

Figure 4. Open the Wi-Fi connect source file.

4. Edit the Wi-Fi SSID and password fields in **WifiConnectWindow.cpp** with the values for a personal hotspot (**Figure 5**).

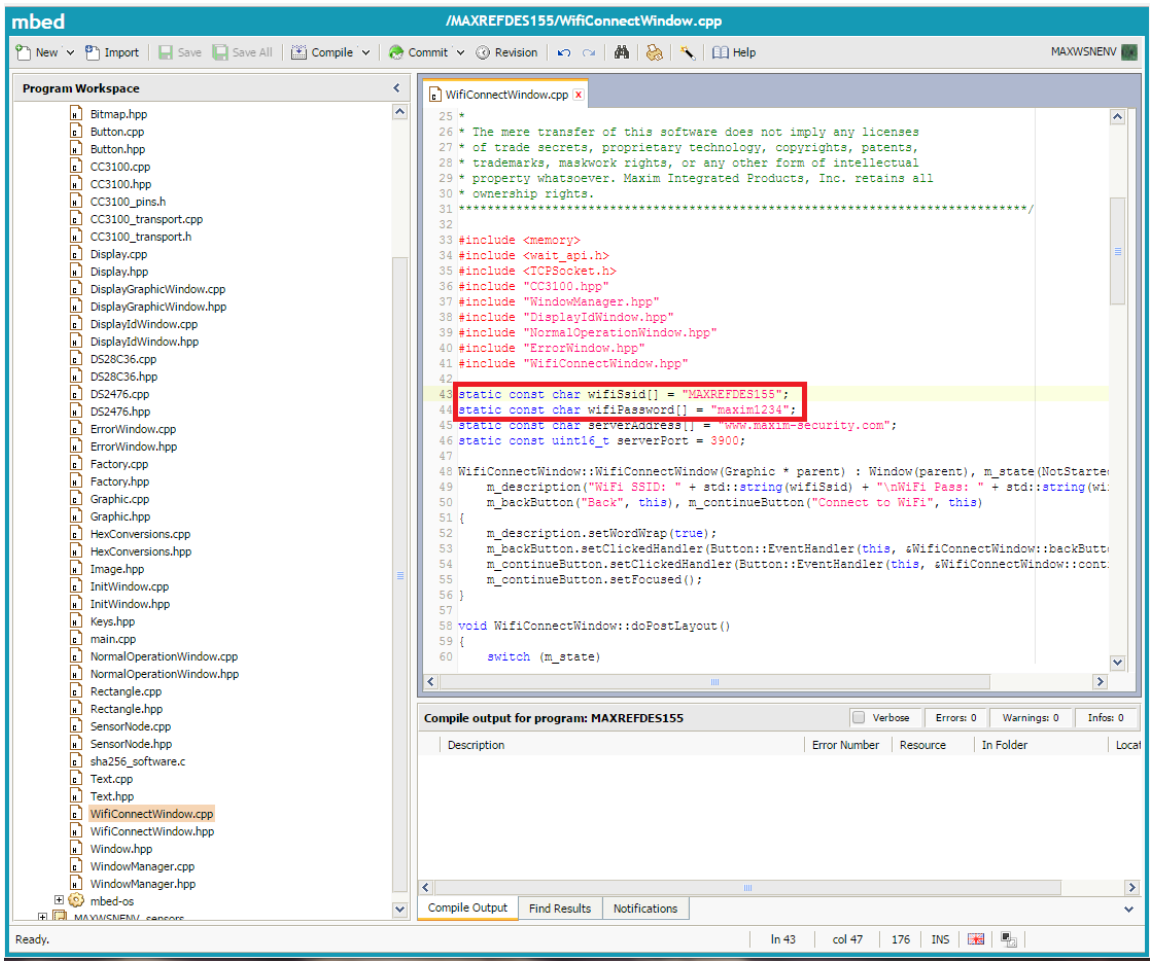

Figure 5. Editing the Wi-Fi SSID and password fields for personal hotspot.

5. You will be prompted to download "MAXREFDES155.bin," which is the compiled binary firmware. **Compile** the firmware (**Figure 6**).

Figure 6. Compiling the firmware.

6. Connect the MAX32600MBED to the computer using the HDK USB port for programming (**Figure 7**).

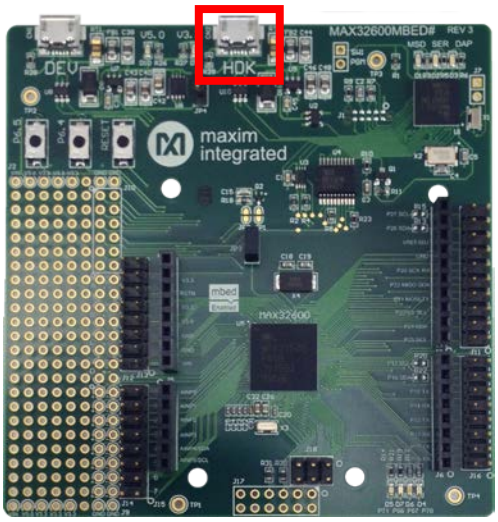

Figure 7. Connect the MAX32600MBED to a computer using the HDK USB port.

7. The MAX32600MBED# acts as a USB-storage drive when connected to the computer. Drag the **MAXREFDES155_MAX32600MBED.bin** binary to the **MBED** USB storage drive to program the MAX32600MBED. When done transferring the binary, safely disconnect (eject) the MAX32600MBED# HDK USB port as you would any USB storage drive.

Demo Setup

This section describes the steps to setup the hardware for the demo.

1. Connect the IR-laser-sensor module (J7) to the MAXREFDES155# mbed shield (J3) using the supplied SR cable.
2. Insert the downward facing pins on the MAXREFDES155# assembly into the MAX32600MBED# as shown (**Figure 8**).

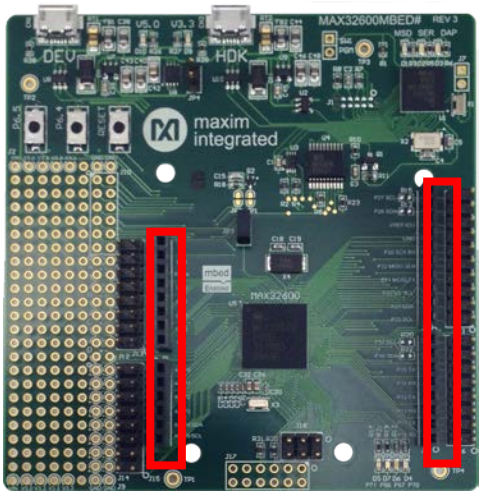

Figure 8. Inserting pins on the MAXREFDES155# shield into the MAX32600MBED# base board.

3. Power the MAX32600MBED# through the DEV USB port (**Figure 9a**). Click any key to begin and the LCD immediately displays the unique Web ID for the MAXREFDES155# mbed shield (**Figure 9b**). This is used for session tracking on the web server. Write down this session Web ID for later.

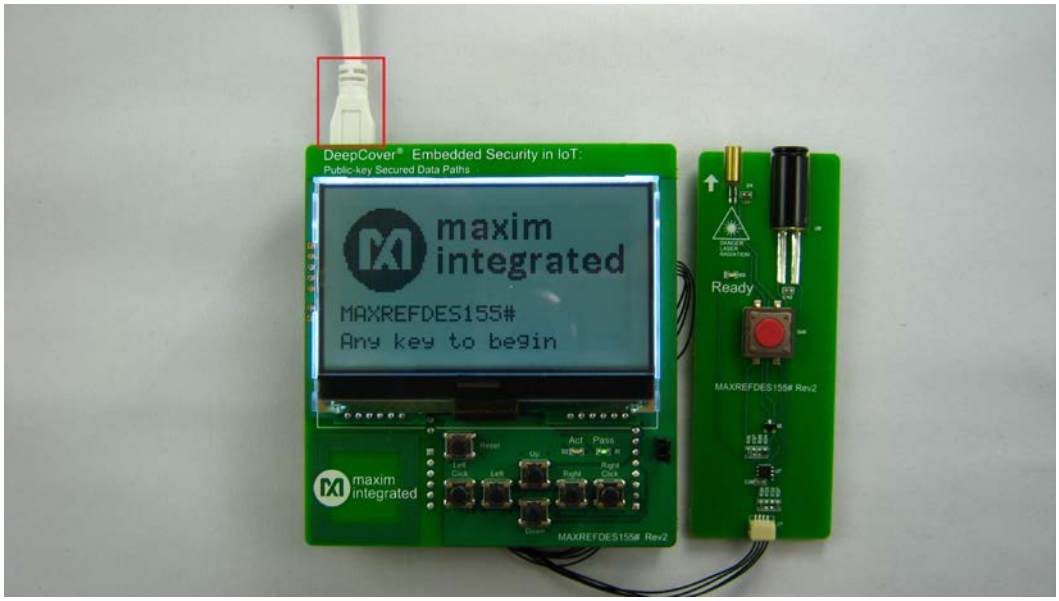

Figure 9a. Power the MAX32600MBED# and MAXREFDES155# using the DEV USB port.

Figure 9b. Display the Web ID.

4. With a PC, go to www.maxim-security.com and click on the MAXREFDES155# image (**Figure 10**).

Figure 10. Embedded Security in IoT home page.

5. Type in the 64-bit Web ID that you wrote down from the **Demo Setup,** step 3 as shown in **Figure 11,** and click on **Continue**

Figure 11. and enter your mbed Web ID.

6. Verify the PC is connected to the web server as shown in **Figure 12**.

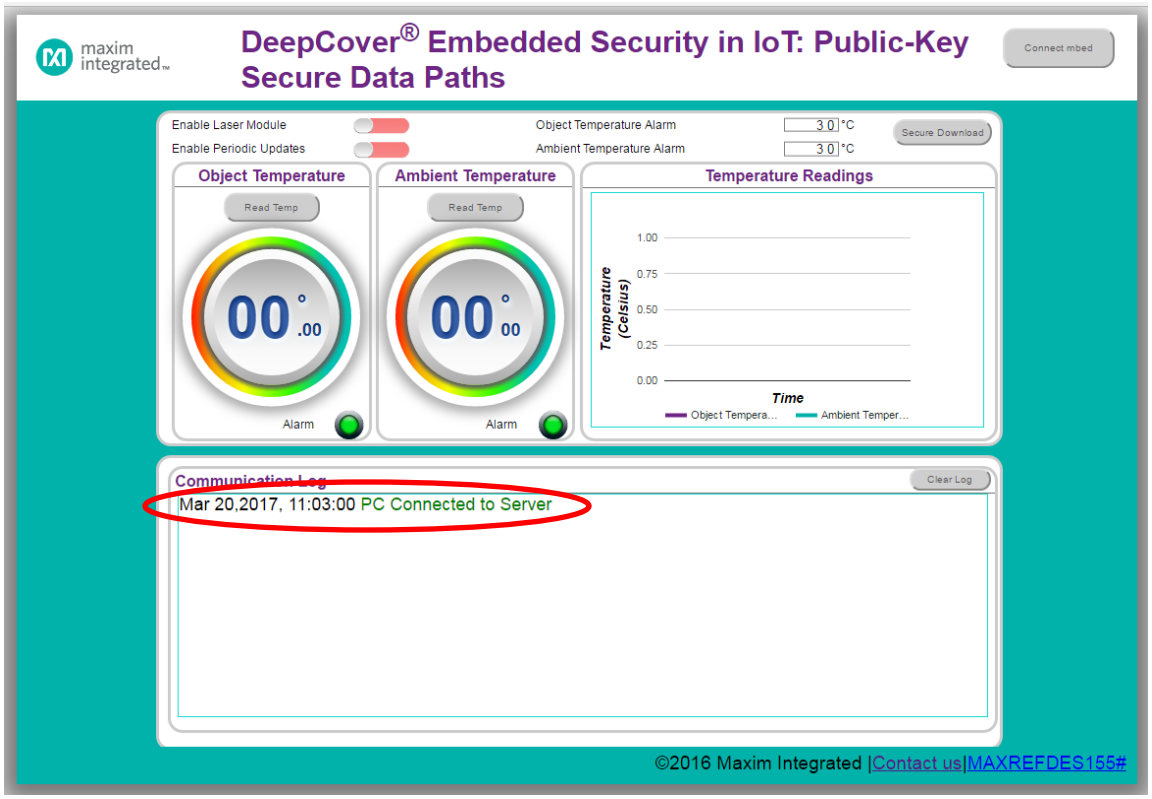

Figure 12. Verify the PC Connected to Server.

7. Provide the internet hotspot setup with the network name and network password with the values created for **Figure 5**. Make sure to place the hotspot in reasonable proximity to the mbed.

8. Follow the directions of each step on the LCD screen of the mbed shield using the directional keys (up, down, left, right) to move the selection box between menu options and the **Left Click** key to select options.

9. Verify the mbed shield LCD screen shows **Sensor node: Valid, laser disabled** as shown in **Figure 13** indicating the mbed is sending valid signatures to the web server but the laser is not enabled.

   Note: Toggling the **Use invalid sig.** instructs the mbed to make the generated temperature measurement signatures unauthenticated when using the web client per **Figure 16** and **17**.

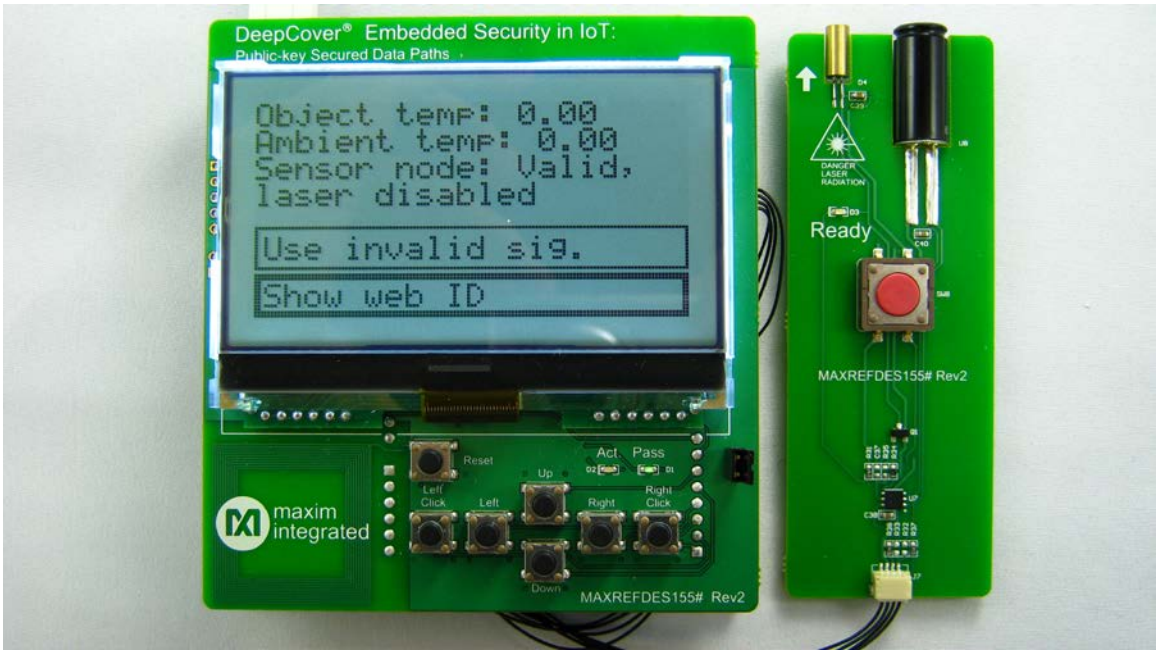

Figure 13. Sending valid signatures to the web server.

10. Verify the web client shows **Data Authenticated** as in **Figure 14**. This is critical as it indicates from the web server that an authentic mbed connection has been recognized. Note: The example web client for this design utilizes a shared instance provided by Maxim for your convenience. Maxim makes no guarantees regarding reliability, availability, or data security when utilizing the shared web-client instance. The authenticated connection recognized in this demo is between the mbed and the web server.

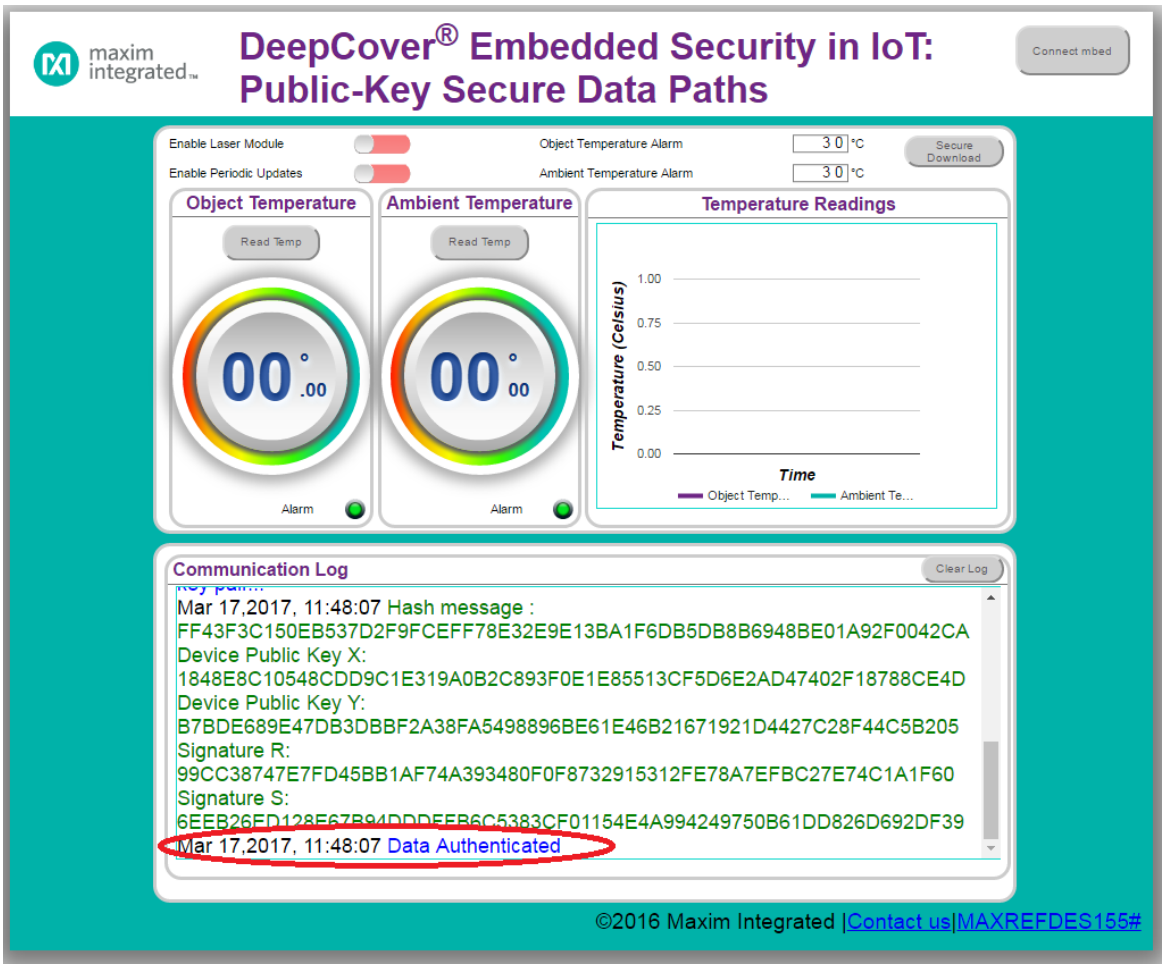

Figure 14. Web server verification that the mbed is Authentic.

11. To summarize, if everything is correct the following (as illustrated in **Figure 15**) shows what occurred to establish a secure connection to the Web Server:

    a. mbed connects to the web server through Wi-Fi.

    b. The web server sends a signed command and challenge requesting the mbed's identity information.

    c. mbed verifies command and sends Web ID, device public key, key certificate, and signature generated from preceding data and provided challenge to the web server.

    d. The web server uses the system public key to verify mbed is part of the system by checking the certificate.

    e. The web server verifies the signature by using the received data challenge, and device public key. If the mbed is authenticated, then the web server allows the connection. If not authenticated, the web server drops the mbed connection and does not accept any incoming data.

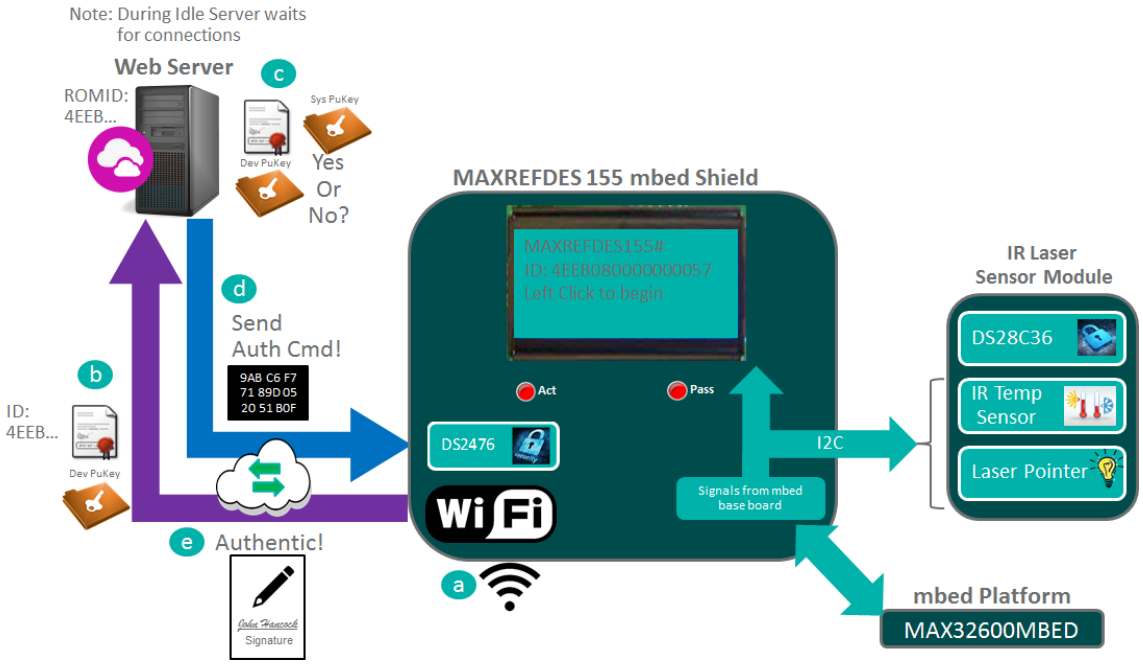

Figure 15. Establishing the setup connection to the web server.

Run the Demo

Temperature Demo

A web client runs the demo by executing the mbed commands and displaying the results of temperature that was authenticated by the web server. After the **Demo Setup** has successfully completed do the following to run this demo:

1. Click on the **Enable Laser Module** so the laser-pointer power is enabled securely. Note: For safety, when the mbed receives the enable sensor module, the DS2476 authenticates the DS28C36. If the DS28C36 is found authentic then the DS28C36 GPIO is enabled by a write authentication. This in turn enables the laser-pointer power. Otherwise, the DS28C36 GPIO is kept disabled which in turn keeps the laser pointer in a safe state.

2. Click on the **Read Temp** button (**Figure 16**) and verify a temperature was read and is authentic.

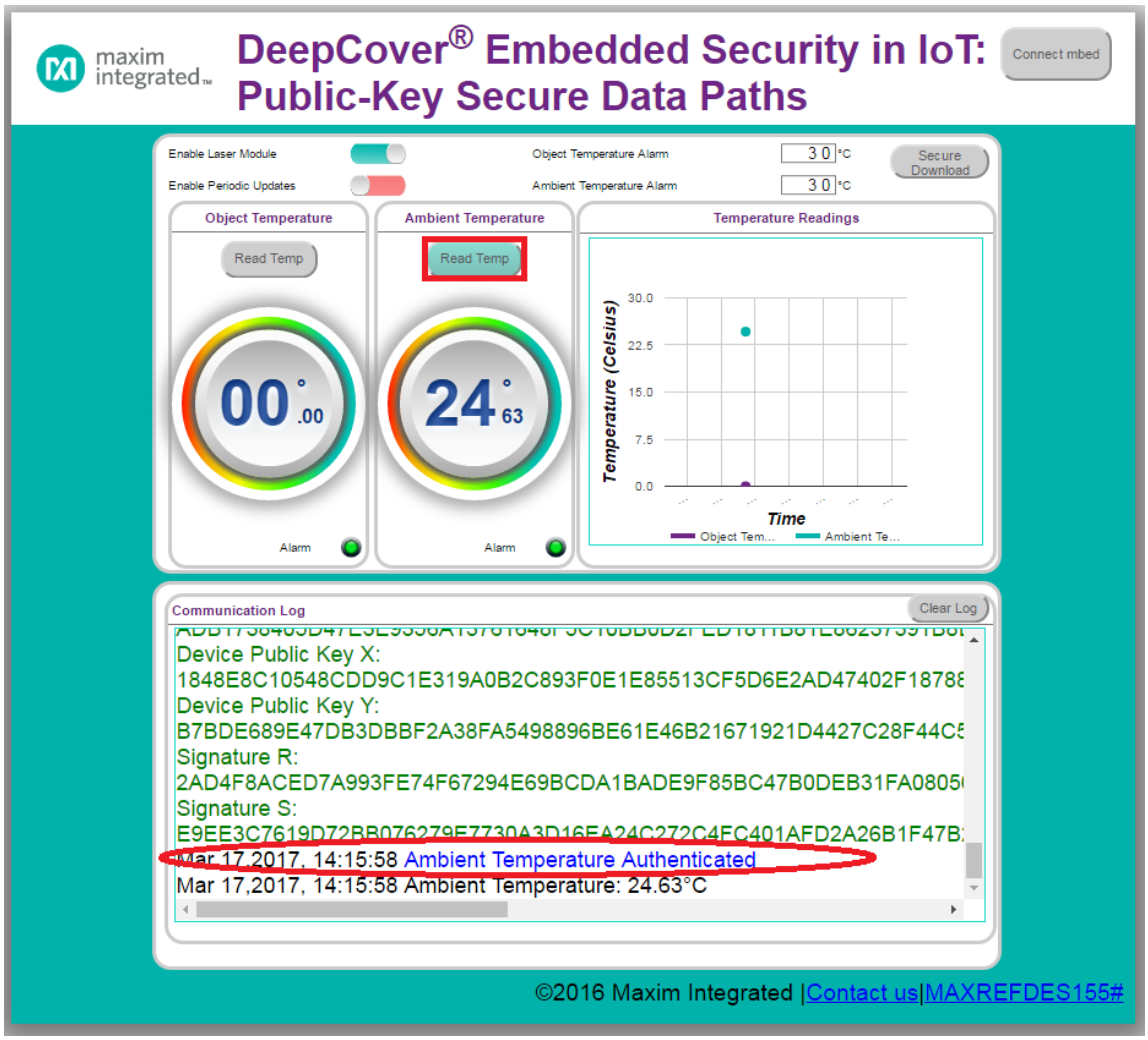

Figure 16. An authenticated temperature reading.

3. Slide the **Enable Periodic Updates** and this continually requests and receives an authenticated temperature reading while graphing a log of the results in the **Temperature Readings** panel. The increments of the temperature readings occur every five seconds. Each reading can be verified to be authentic as listed in the **Communication Log** panel as shown in **Figure 17**.

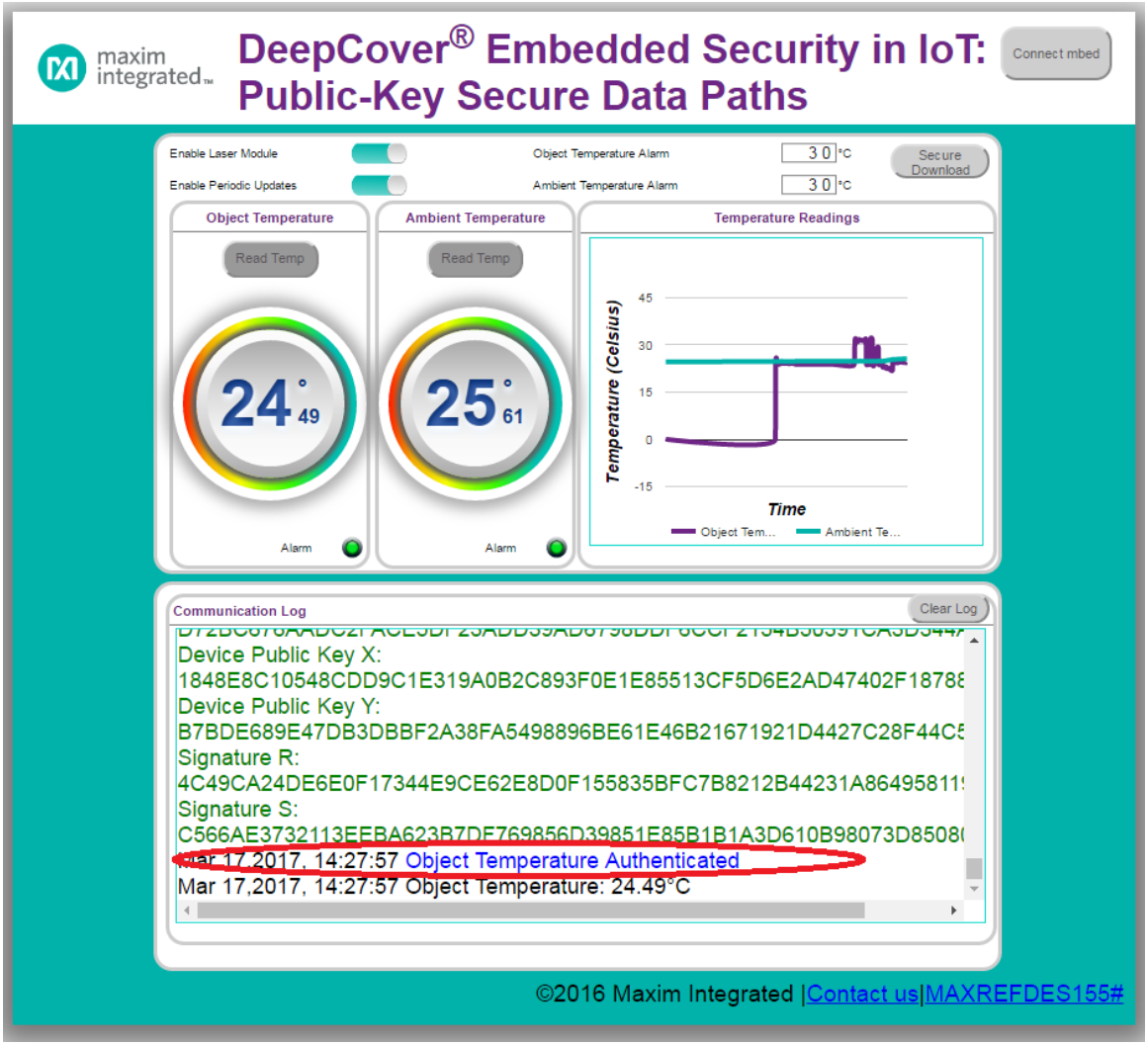

Figure 17. An Authenticated temperature reading with history graphed.

4. In summary, the **Temperature Demo** authenticates temperature each time by doing the following (**Figure 18**):

    a. The mbed receives a get temperature command along with the challenge from the web server (i.e., it is instructed by the web client).

    b. On the mbed, DS2476 locally authenticates (i.e., by using a locally symmetric-based authentication with HMAC SHA-256) the DS28C36 on the sensor module and locally reads the temperature.

    c. Assuming the sensor module is declared authentic, the mbed reads and signs the temperature reading with the device private key in DS2476 and the received challenge. The mbed sends the temperature reading and signature to the web server.

    d. The web server uses the device public key obtained beforehand during the **Demo Setup**, the challenge, and the just received temperature reading/signature to verify authenticity.

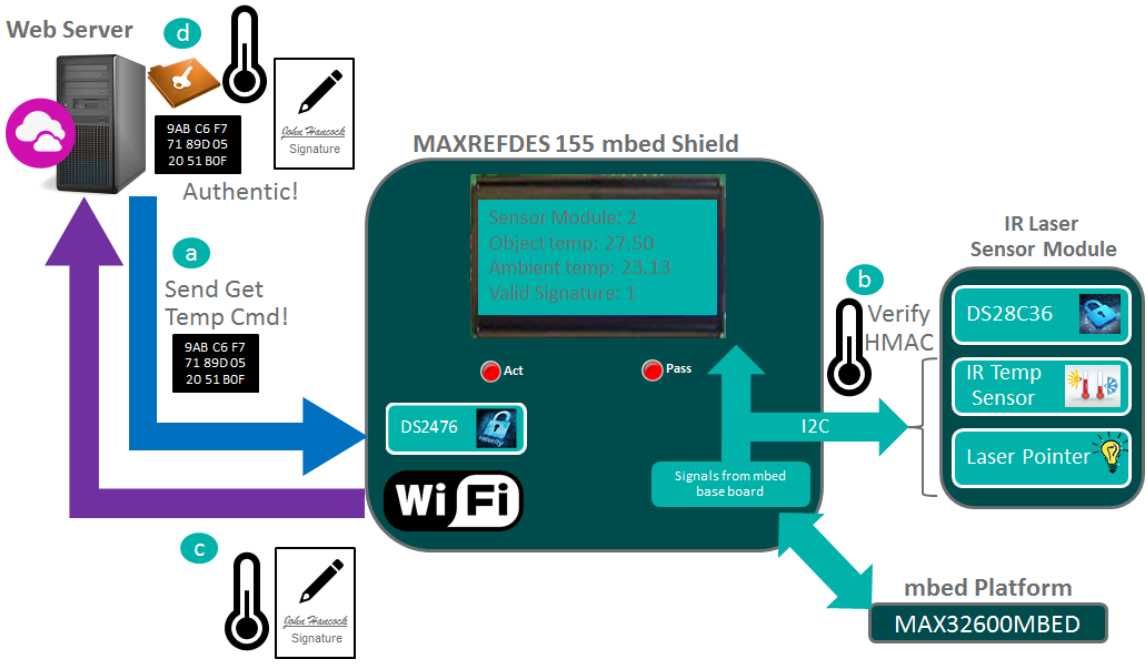

Figure 18. An illustration of Authenticated temperature readings.

Image Demo

The web client can also be used to send an image securely to the mbed platform. After the **Demo Setup** has completed successfully, do the following to run this demo:

1. In the web client, click on the **Secure Download** button and a popup window opens.
2. Select an image to download, check the **Valid** box so the image has a digital signature generated/used that is valid and click on **Download** to send the image to the LCD display of the mbed shield (**Figure 19**).

   Note: The web client contains the color images and the correlating black & white LCD image.

Figure 19. Select image to download.

3. Verify the MAXREFDES155# mbed shield shows the selected iButton® image in black and white on the LCD display.
4. In summary, the **Image Demo** authenticates the image each time by doing the following:
   a. The web client sends the LCD image bytes and settings to the web server. (Figure 18)
   b. The web server uses system private keys and signs the LCD image data. The web server checks the **Valid** flag. If not checked, the web server corrupts the LCD image data after simulating a man-in-the-middle attack. Then, it sends the LCD image data and signature to mbed.
   c. The mbed gets the LCD image data plus the correlating signature and verifies the signature.
      - If the signature passes, then the mbed LCD shows the image.
      - If the signature fails, then the mbed LCD does not show the image but an error message.

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