



MangOH Arduino Tutorial

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1 Summary of Document

This document contains a tutorial on how to update an existing Arduino sketch and have the data read by sketch updated on AirVantage. In addition, data updates from AirVantage will also be interpreted by the updated Arduino sketch.

2 Introduction

Software has been created for the MangOH project to allow Arduino sketch writers to use the Arduino Yun Bridge to push and retrieve data to/from AirVantage (or other Legato applications). For this tutorial we will start with a sketch measuring temperature and humidity.

Note it is assumed that the following has already been completed before starting this tutorial:

- The Arduino software has already been installed on the user's PC. See <https://www.arduino.cc/en/Main/Software> to install the Arduino software.
- The legato toolset has already been installed on the user's Linux PC.
- The user has an AirVantage account
- The MangOH device has already been configured on AirVantage

3 Arduino Sketch

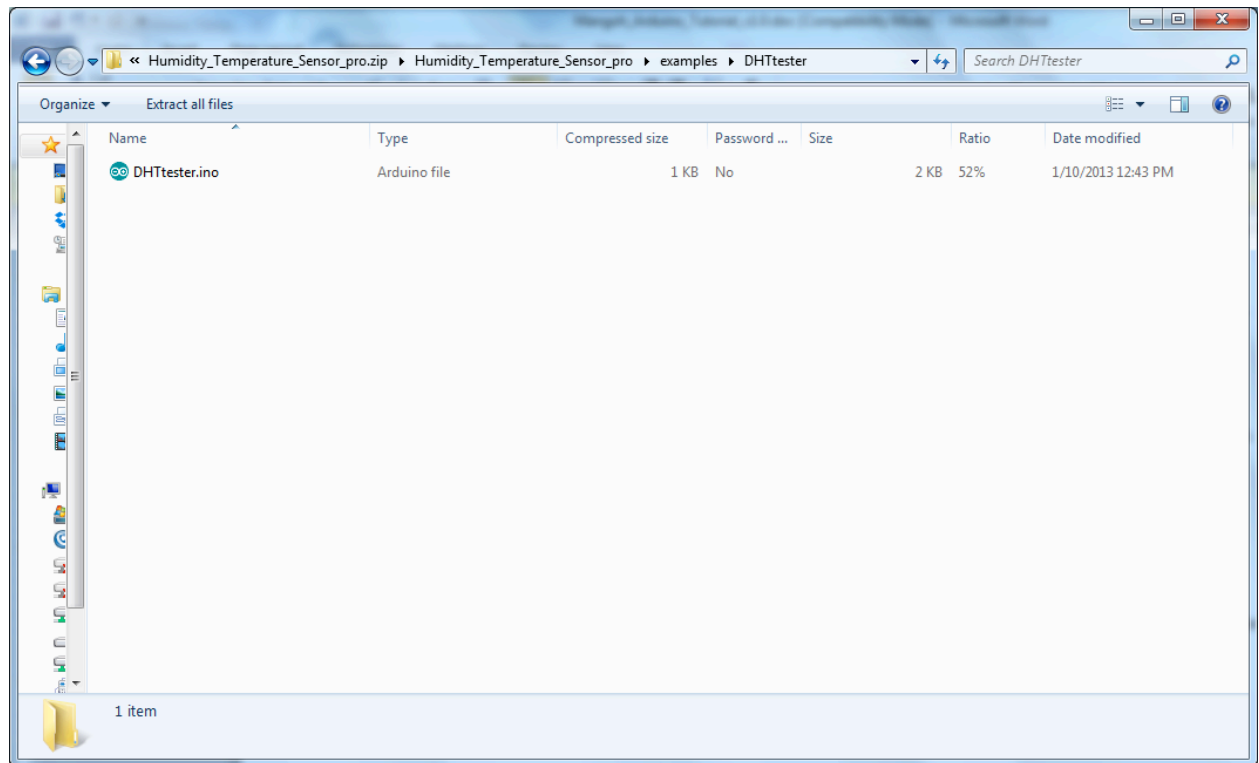
The Arduino sketch for this tutorial was retrieved from http://www.seeedstudio.com/wiki/File:Humidity_Temperature_Sensor_pro.zip.

3.1 Load and Running Sketch

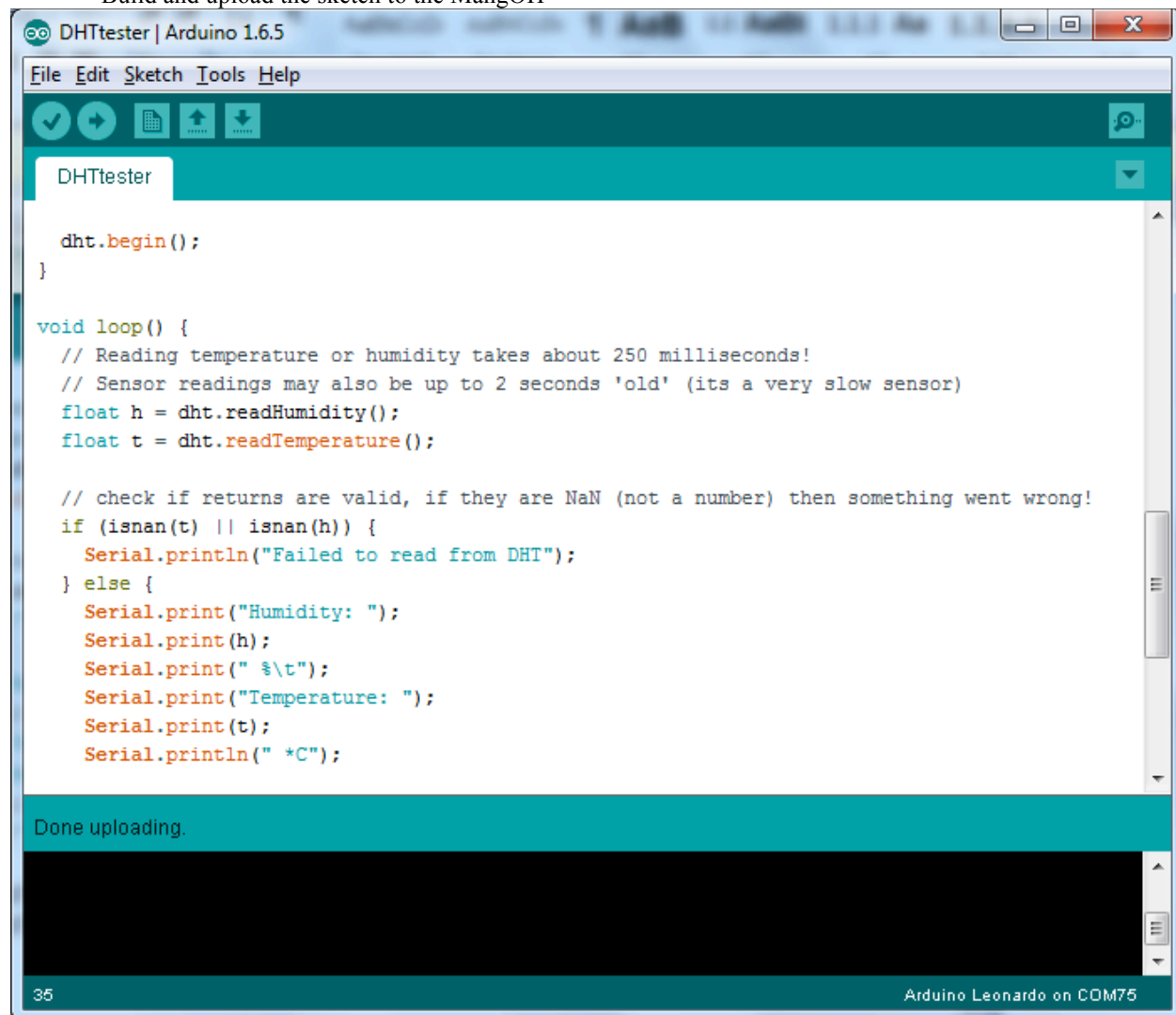
Execute the following steps to run the sketch:

- Hardware set-up:
 - Attach shield to Mangoh board
 - Attach temperature/humidity sensor to pin D2 on the shield
 - Connect USB cable from Mangoh to PC
- Extract the .zip file to a local folder. The contents of the zip file extracted in the *Humidity_Temperature_Sensor_pro* folder.

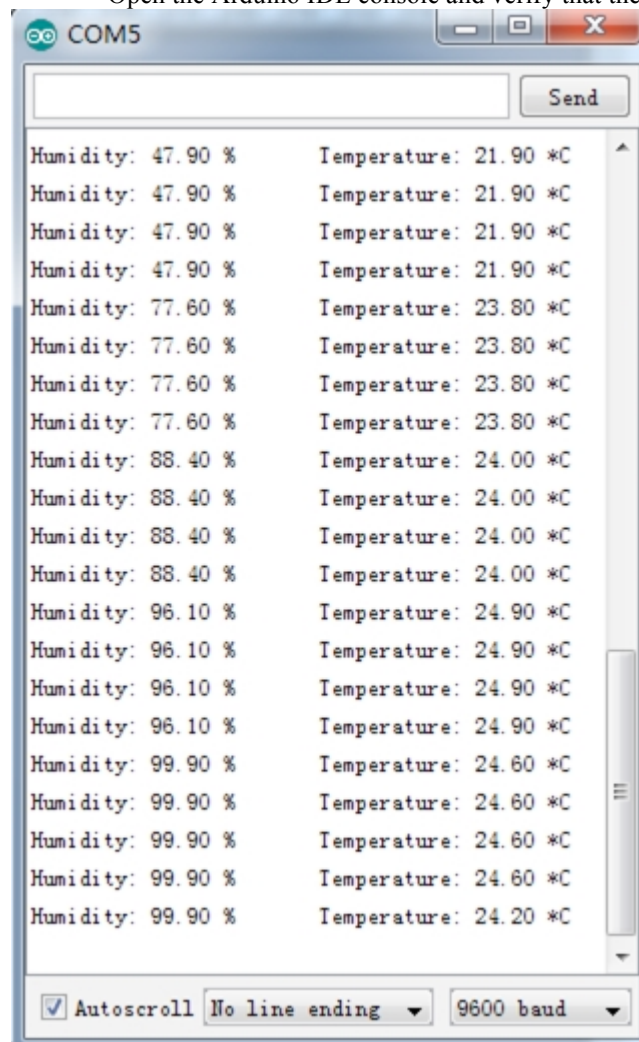
- Open the Arduino sketch *DHTtester.ino* file found in the examples folder



- Build and upload the sketch to the MangOH



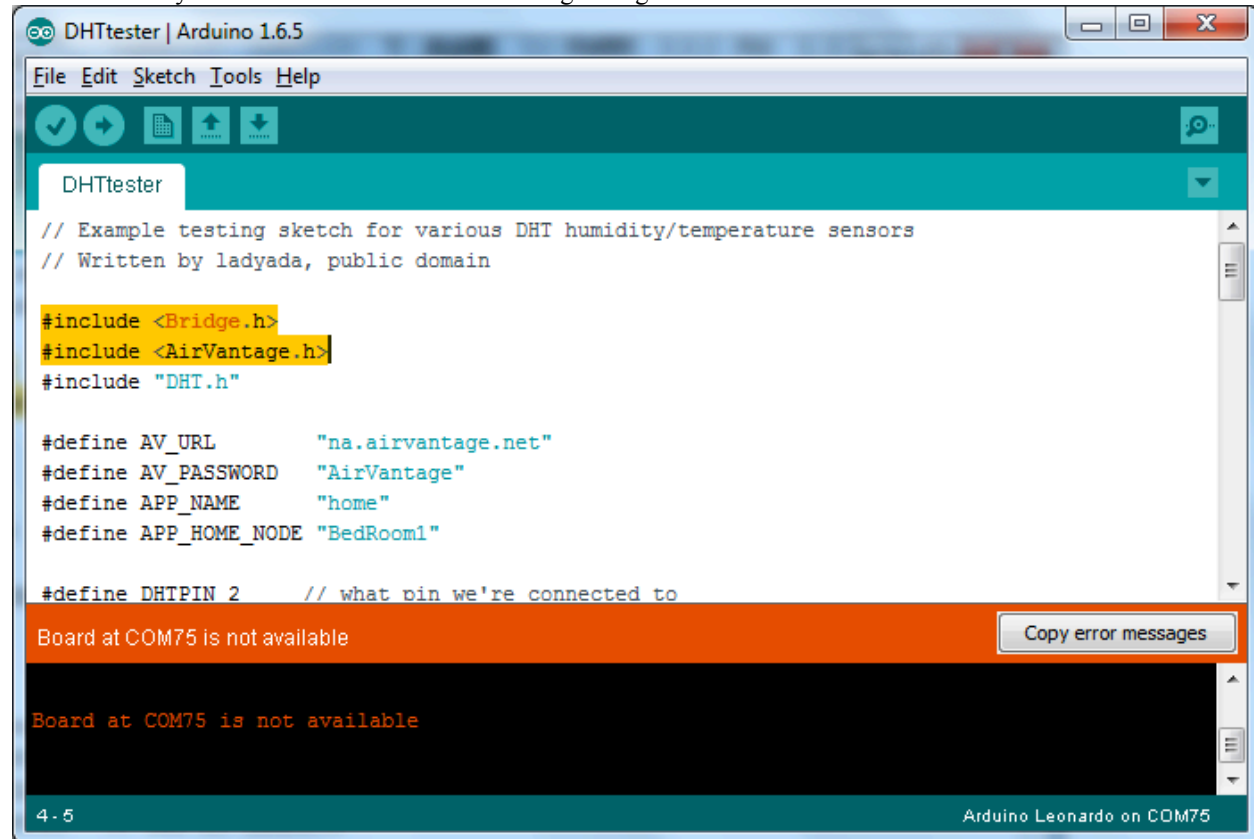
- Open the Arduino IDE console and verify that the sketch is operating and reading correct values



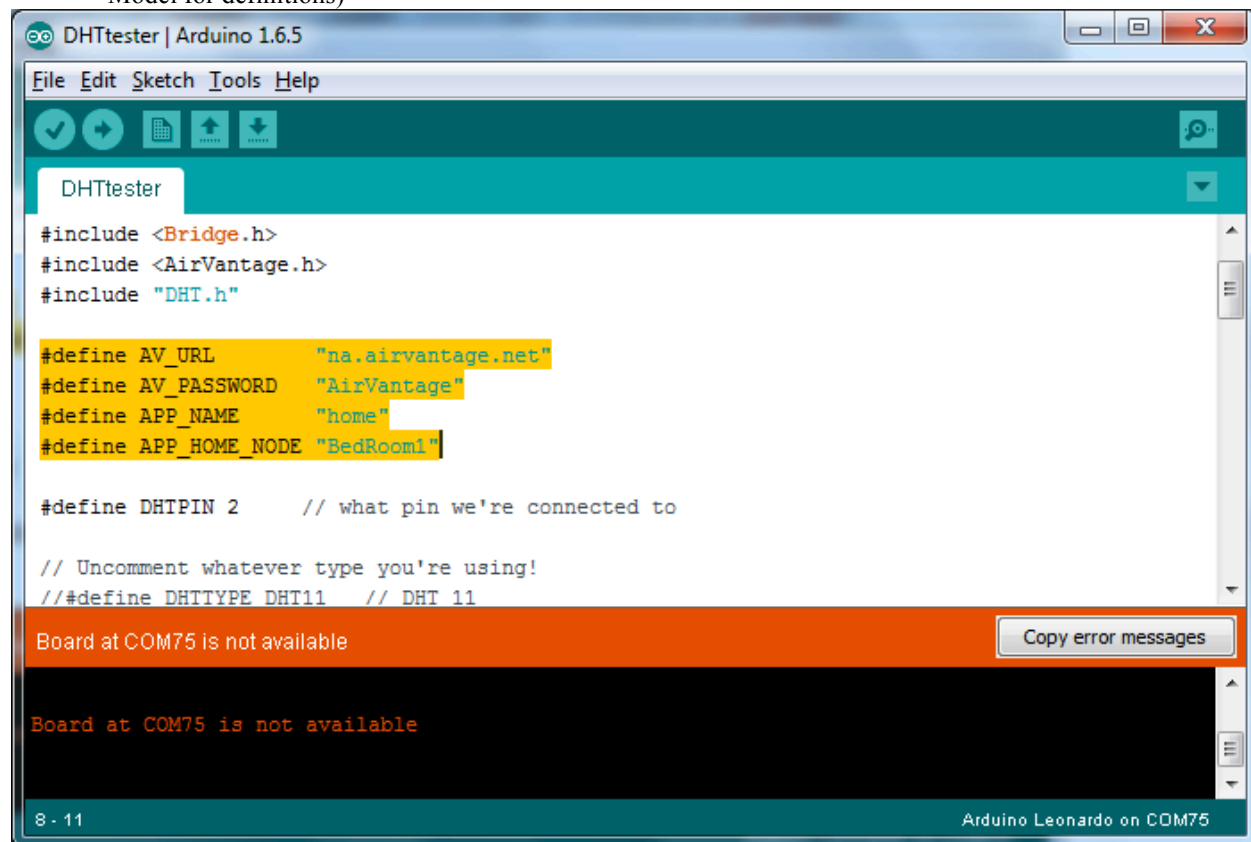
3.2 Update Sketch for AirVantage Arduino Yun Bridge

The following steps are required to update the sketch to use the AirVantage Arduino Yun Bridge:

- Download the AirVantage.zip file containing the Arduino Yun Bridge AirVantage protocol extension library
- Add the library to the DHTtester sketch using the Sketch | Include Library | Add .ZIP Library menu
- Modify the sketch to include the AirVantage bridge libraries



- Add the AirVantage URL and password as well as the AirVantage field name prefixes (see the Application Model for definitions)



- Update the sketch's *setup()* function to open and initialize the Arduino Yun Bridge and start a new AirVantage session

```
DHTtester | Arduino 1.6.5
File Edit Sketch Tools Help

DHTtester
// Connect a 10K resistor from pin 2 (data) to pin 1 (power) of the sensor

DHT dht(DHTPIN, DHTTYPE);

void setup() {
  Serial.begin(9600);
  Serial.println("DHTxx test!");

  Bridge.begin();
  AirVantage.begin();

  Serial.print("Start Session: ");
  Serial.print(AV_URL);
  Serial.print(" ");
  Serial.println(AV_PASSWORD);
  AirVantage.startSession(AV_URL, AV_PASSWORD, MQTT, PERSIST);

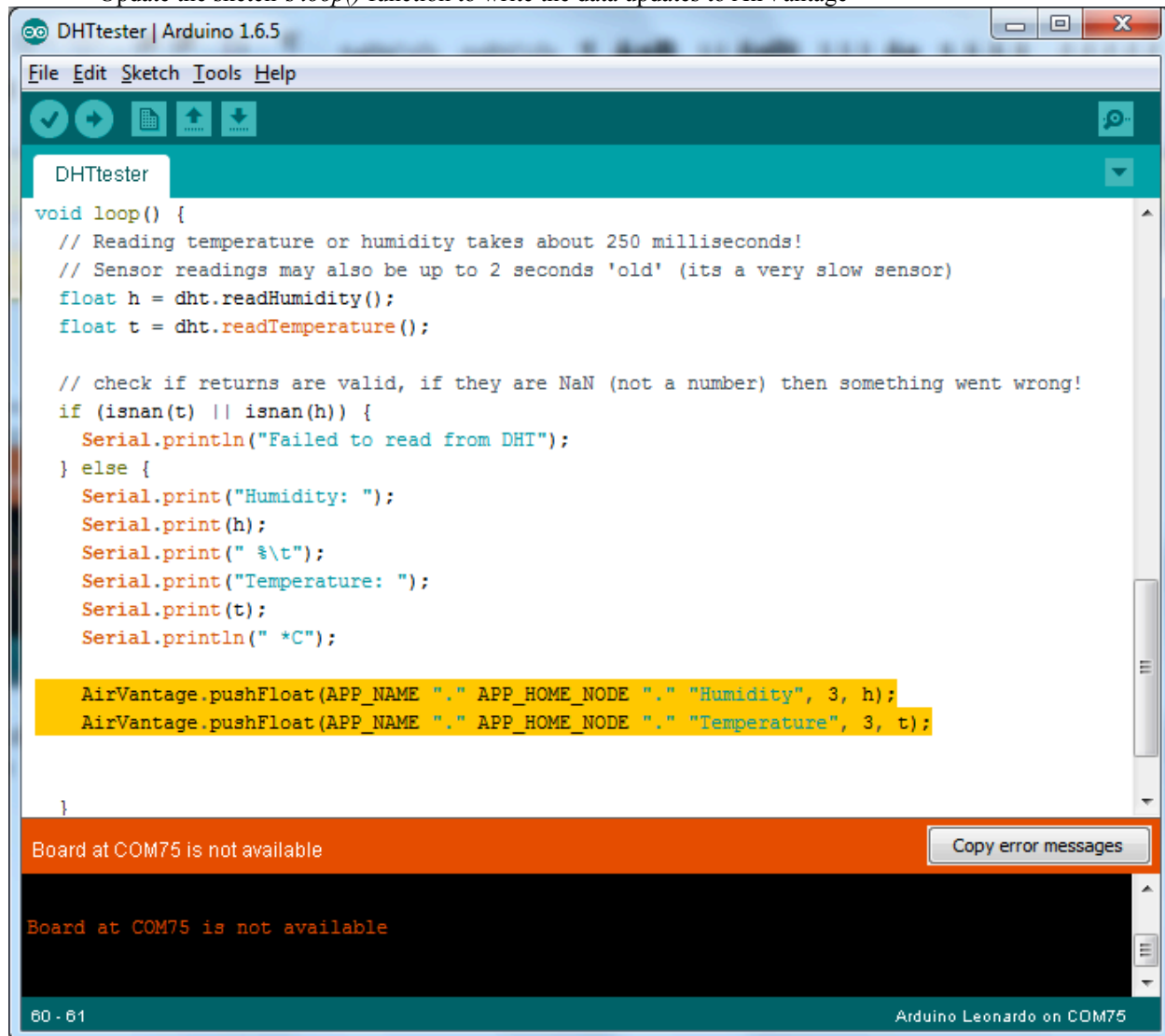
  dht.begin();
}

void loop() {

Done uploading.

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```

- Update the sketch's *loop()* function to write the data updates to AirVantage



The screenshot shows the Arduino IDE interface. The title bar reads "DHTtester | Arduino 1.6.5". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for checking, running, saving, uploading, and downloading. The sketch name "DHTtester" is shown in the top right of the editor area. The code in the editor is as follows:

```
void loop() {  
  // Reading temperature or humidity takes about 250 milliseconds!  
  // Sensor readings may also be up to 2 seconds 'old' (its a very slow sensor)  
  float h = dht.readHumidity();  
  float t = dht.readTemperature();  
  
  // check if returns are valid, if they are NaN (not a number) then something went wrong!  
  if (isnan(t) || isnan(h)) {  
    Serial.println("Failed to read from DHT");  
  } else {  
    Serial.print("Humidity: ");  
    Serial.print(h);  
    Serial.print(" %\t");  
    Serial.print("Temperature: ");  
    Serial.print(t);  
    Serial.println(" *C");  
  
    AirVantage.pushFloat(APP_NAME "." APP_HOME_NODE "." "Humidity", 3, h);  
    AirVantage.pushFloat(APP_NAME "." APP_HOME_NODE "." "Temperature", 3, t);  
  
  }  
}
```

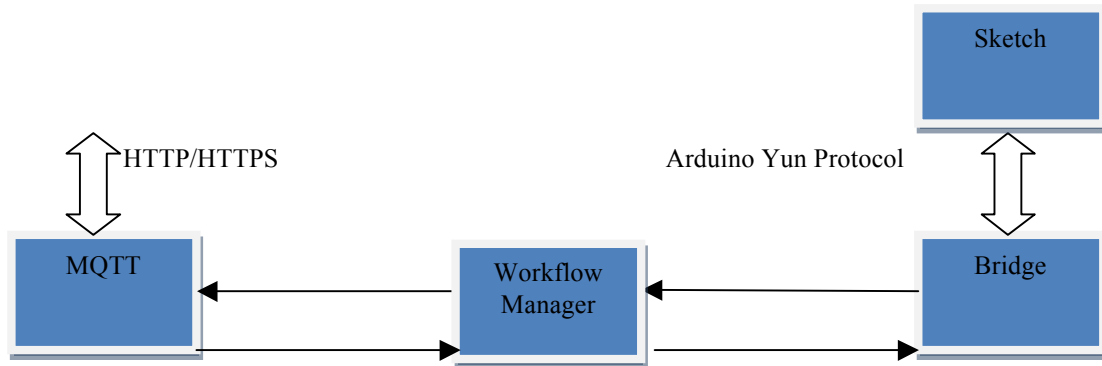
Below the code editor, an orange error message bar states "Board at COM75 is not available" with a "Copy error messages" button. The serial monitor at the bottom shows the same error message: "Board at COM75 is not available". The status bar at the bottom indicates "60 - 61" and "Arduino Leonardo on COM75".

4 Legato Software

In order for the Arduino sketch to communicate with the WP the following three Legato applications are required to be installed and running:

- Arduino Yun Bridge
- Workflow Manager
- MQTT

The diagram below shows the data flows between AirVantage, MQTT/Workflow Manager/Bridge Legato applications and the Arduino sketch:



4.1 MQTT

The MQTT application provides an interface for applications to push data to AirVantage. Do the following to install and run the MQTT:

- Download the mqttClient.wp85 file to a Linux workstation with the Legato toolset already installed.
- Install the MQTT application using the *instapp* Legato command
- The MQTT is configured to auto-start so the application will start automatically after the application is downloaded

4.2 Workflow Manager

The Workflow Manager application is a Legato application that performs the following operations:

- Acts as a central database for all data values
- Receives published data updates and stores the values in its database
- Updates data subscribers when data values are update
- Routes published data updates to AirVantage (if configured to do so)

Do the following to install and run the Workflow Manager:

- Download the SwiMangohWorkflowMgr.wp85 file to a Linux workstation with the Legato toolset already installed.
- Install the SwiMangohWorkflowMgr application using the *instapp* Legato command
- The SwiMangohWorkflowMgr is configured to auto-start so the application will start automatically after the application is downloaded

4.3 Arduino Yun Bridge

The Arduino Yun Bridge application is a Legato application which executes the slave side of the Arduino Yun Bridge protocol. The Arduino Yun Bridge supports all of the existing protocol extensions (File I/O, Console, Mailbox, Process, Socket). In addition the Arduino Yun Bridge supports the AirVantage Arduino Yun extension developed for the MangOH project. Do the following to install and run the Arduino Yun Bridge:

- Download the SwiMangohBridge.wp85 file to a Linux workstation with the Legato toolset already installed.

- Install the SwiMangohBridge application using the *instapp* Legato command
- The SwiMangohBridge is configured to auto-start so the application will start automatically after the application is downloaded

5 AirVantage

The following sections show how view that Arduino sketch data updates and how to create an install Application Models which are required in order to send data updates to the Arduino sketch from AirVantage.

5.1 Create and Install an Application Model

An application Model is required to create Custom Commands to write data from AirVantage to the sketch. The Application Model used for this tutorial was called 'arduino-alarm'. Application Models are created from XML files. The following XML file was used to create the 'arduino-alarm' Application Model:

```
<?xml version="1.0" encoding="UTF-8"?>

<app:application xmlns:app="http://www.sierrawireless.com/airvantage/application/1.0"
type="com.demo" name="arduino-alarm" revision="0.0.3">
  <capabilities>

    <communication>
      <protocol comm-id="IMEI" type="MQTT"/>
    </communication>

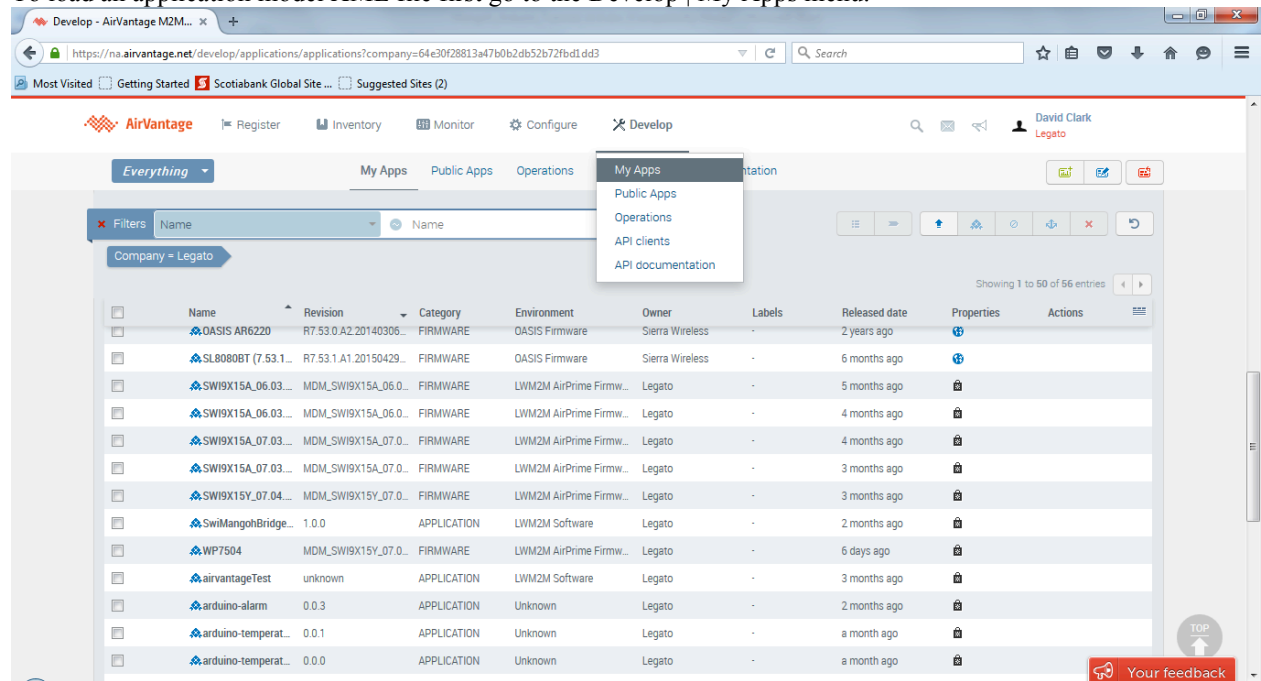
    <data>
      <encoding type="MQTT">
        <asset default-label="My Home" id="home">
          <setting default-label="Motion Detected" path="motion" type="int"/>
          <command path="TurnOn" default-label="Turn on">
            <parameter id="Alarm" default-label="Alarm" type="boolean"/>
          </command>
          <command path="BedRoom1" default-label="Bed Room 1">
            <parameter id="Light" default-label="Light" type="boolean"/>
            <parameter id="AirConditioner" default-label="Air Conditioner" type="int"/>
            <parameter id="Shutters" default-label="Shutters" type="boolean"/>
          </command>
        </asset>
      </encoding>
    </data>

  </capabilities>
</app:application>
```

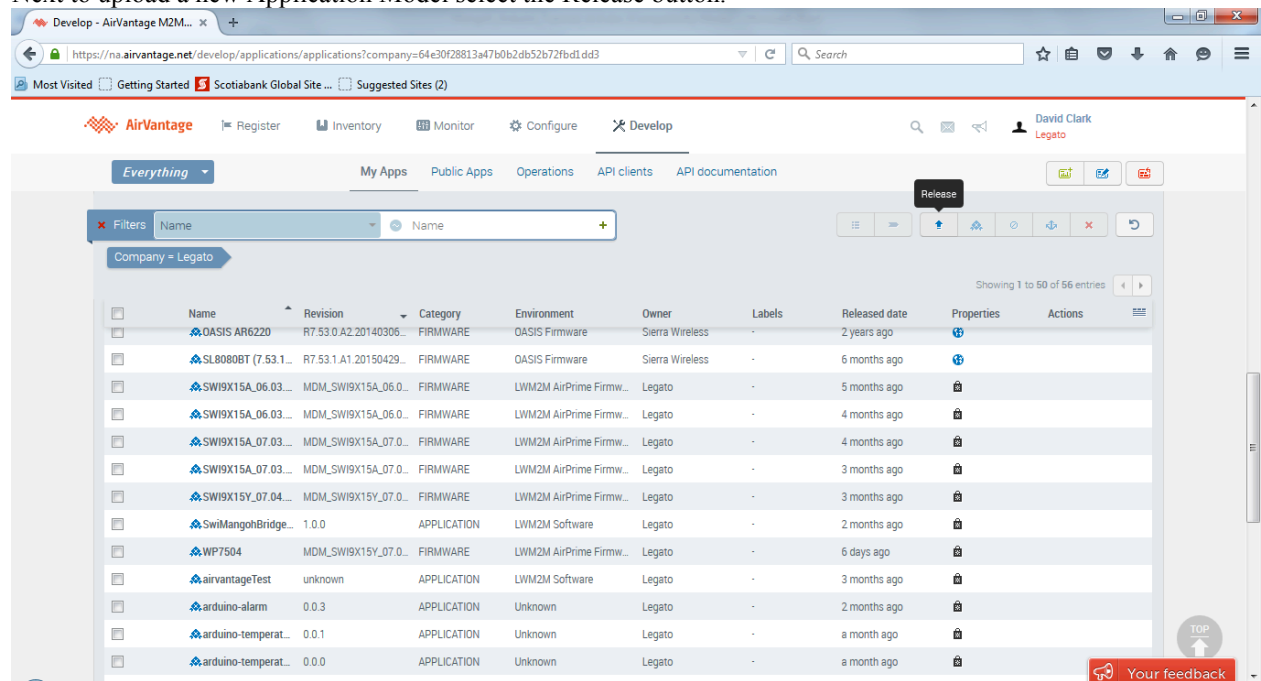
Note that highlighted in **RED** are the application name and application node name fields defined in the sketch. The field names for the parameters found in this application model will be as follows:

- Home.BedRoom1.Light
- Home.BedRoom1.Shutters
- Home.BedRoom1.AirConditioner

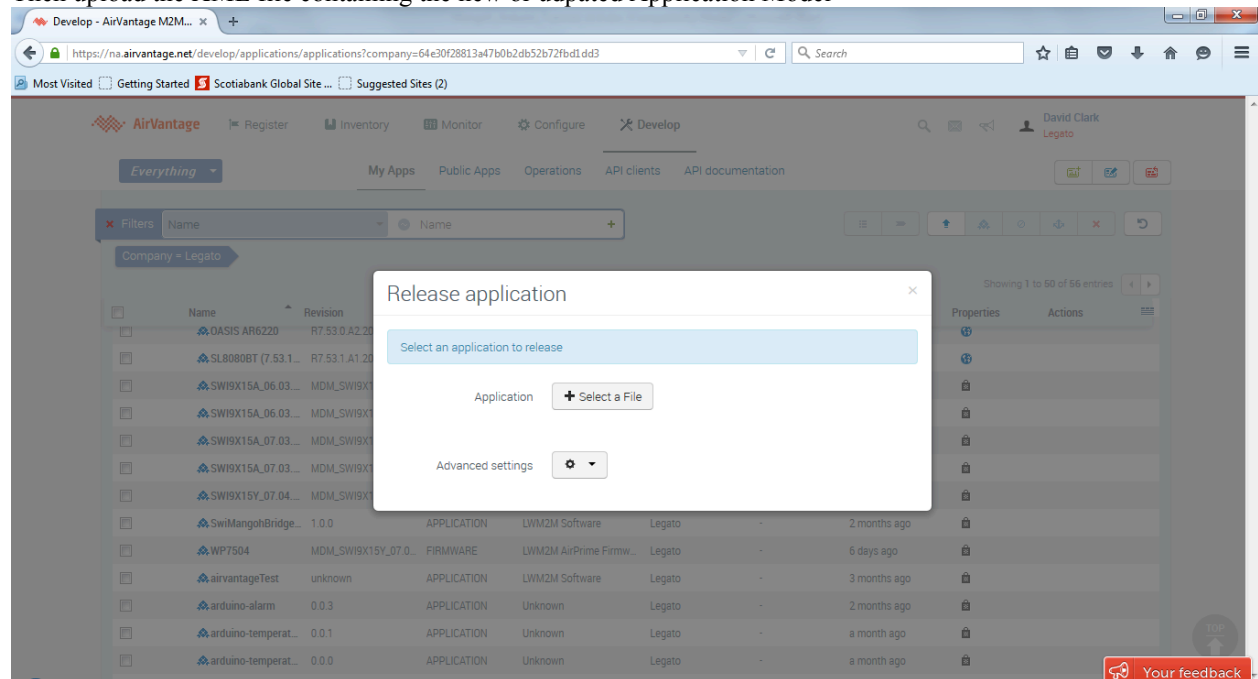
To load an application model XML file first go to the Develop | My Apps menu.



Next to upload a new Application Model select the Release button.



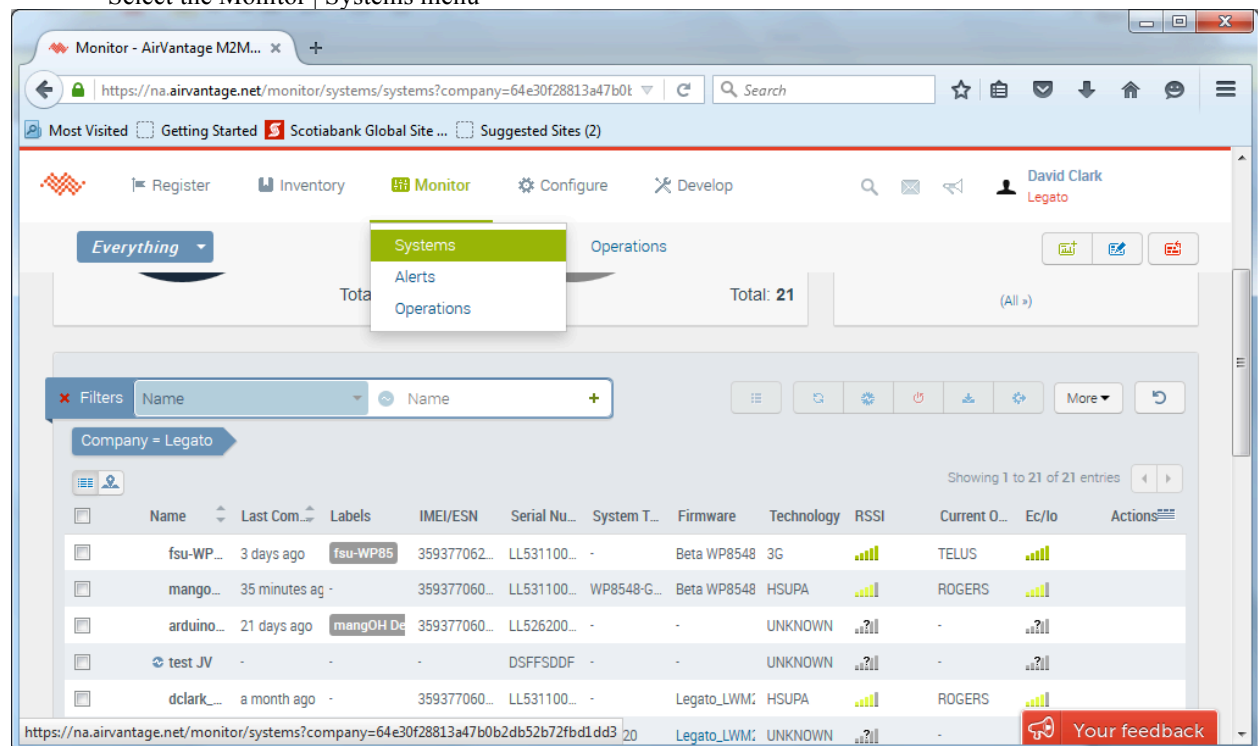
Then upload the XML file containing the new or updated Application Model



5.2 View Arduino Sketch Data on Device Timeline

To view data updates from the sketch on AirVantage do the following steps:

- Login to AirVantage
- Select the Monitor | Systems menu



- Select the ManOH device that was configured before starting this tutorial

The screenshot shows the AirVantage Monitor web interface. The browser address bar displays the URL: <https://na.airvantage.net/monitor/systems/systems?company=64e30f28813a47b0t>. The interface includes a navigation bar with tabs for Register, Inventory, Monitor, Configure, and Develop. The 'Monitor' tab is active, and the 'Systems' sub-tab is selected. A summary bar shows 'Total: 21' systems. Below this, a filter bar shows 'Company = Legato'. A table of devices is displayed, with columns for Name, Last Com., Labels, IMEI/ESN, Serial Nu., System T., Firmware, Technology, RSSI, Current O., Ec/Io, and Actions. The 'mango' device is selected, and its label 'mangOH' is visible. A 'Your feedback' button is located at the bottom right of the table.

Name	Last Com.	Labels	IMEI/ESN	Serial Nu.	System T.	Firmware	Technology	RSSI	Current O.	Ec/Io	Actions
fsu-WP...	3 days ago	fsu-WP85	359377062...	LL531100...	-	Beta WP8548	3G	...	TELUS	...	
<input checked="" type="checkbox"/> mango...	35 minutes ag		359377060...	LL531100...	WP8548-G...	Beta WP8548	HSUPA	...	ROGERS	...	
arduino...	21 days ago	mangOH De	359377060...	LL526200...	-	-	UNKNOWN	...	-	...	
test JV	-	-	-	DSFFSDDF	-	-	UNKNOWN	...	-	...	
dclark...	a month ago	-	359377060...	LL531100...	-	Legato_LWM	HSUPA	...	ROGERS	...	
Vincent...	2 days ago	-	352767050...	GM34250...	AR6220	Legato_LWM	UNKNOWN	...	-	...	

- View the Timeline for the device

The screenshot shows the 'Monitor - AirVantage M2M...' browser window. The address bar displays the URL: <https://na.airvantage.net/monitor/systems/systemDetails?uid=296b80320dd74f03a>. The navigation bar includes links for Register, Inventory, Monitor (active), Configure, and Develop. The user profile 'David Clark Legato' is visible. The breadcrumb trail is 'Systems > mangoh-demo-3'. The page title is 'mangoh-demo-3'. Below the title, there are tabs for Configuration, Timeline, and Data History. The 'System info' section displays the following details:

Category	Value
Technology	HSUPA
Signal information	
Details	RSSI -81.0 Ec/Io -9.0
Traffic	Bytes sent: 14 kB Bytes received: 2 kB
Current Operator	ROGERS
IP Address	25.77.201.108
Firmware	Beta WP8548-G (da63936f0ec49eddec72...
IMEI/ESN	359377060003091
Serial Number	LL531100230102
System Type	WP8548-G (Beta)
Subscriptions	89302720403034974286 - ROGERS
Phone number	+17789856225
Last applied Template	-
Labels	-

A 'Your feedback' button is located at the bottom right.

- View the data updates

The screenshot shows the 'Monitor - AirVantage M2M...' browser window. The address bar displays the URL: <https://na.airvantage.net/monitor/systems/timeline?uid=296b80320dd74f03a06e5e>. The navigation bar is the same as the previous screenshot. The breadcrumb trail is 'Systems > mangoh-demo-3 > Timeline'. The page title is 'Timeline'. Below the title, there is a '1 data point' notification. The 'Data' section shows a single data point: 'home.BedRoom1.Humidity' with a value of '24.299999'. Below this, there is a 'Show full communication details' link. The timeline shows three communication events, all at 11:16:24 AM, all of type 'MQTT', each with a count of '1'. A 'Your feedback' button is located at the bottom right.

5.3 Write Data to Arduino Sketch from AirVantage

AirVantage Custom Commands are used to write data to Arduino sketches. Note that sketches must call the Arduino Yun `AirVantage.available()` and `read()` commands to retrieve the updates from the Arduino Yun Bridge Legato application.

5.3.1 Updated Arduino Sketch for Reading AirVantage Data Updates

The screen capture below shows an updated DHTTester Arduino sketch that will check for and read data updates and dump the data update to the Arduino console.



```
DHTTester
} else {
  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.print(" %\t");
  Serial.print("Temperature: ");
  Serial.print(t);
  Serial.println(" *C");

  AirVantage.pushFloat(APP_NAME "." APP_HOME_NODE "." "Humidity", 3, h);
  AirVantage.pushFloat(APP_NAME "." APP_HOME_NODE "." "Temperature", 3, t);

  String message;
  // read all the data available from Air Vantage
  while (AirVantage.dataAvailable())
  {
    AirVantage.readMessage(message);
    Serial.println(message);
  }

  delay(10000);
}
```

Done Saving.

Board at COM75 is not available

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5.3.2 Create and Send Custom Data Update Command

To create and send data updates from AirVantage to the Arduino sketch execute the following steps:

- Select the Monitor | Systems menu to view the list of configure devices.

- Select the configure MangOH device to write a data update to

The screenshot shows the AirVantage Monitor interface. At the top, there are navigation tabs: Register, Inventory, Monitor (selected), Configure, and Develop. Below the tabs, there are two pie charts showing system status: 'Everything' and 'Systems'. The 'Systems' chart shows a total of 21 systems. Below the charts, there is a table of devices. The 'mangoh-de...' device is selected, and the 'More' menu is open, showing options like 'Send Command'.

Name	Last Comm. d.	Labels	IMEI/ESN	Serial Number	System Type	Firmware	Technology	RSSI	Current Oper...	Ec/lo	Actions
fsu-WP85	3 days ago	fsu-WP85	359377062015...	LL53110008...	-	Beta WP8548-G (3G			TELUS		
mangoh-de...	17 minutes ago		359377060003...	LL53110023...	WP8548-G (B...	Beta WP8548-G (HSUPA			ROGERS		
arduino_de...	21 days ago	mangOH Demo	359377060001...	LL52620009...	-	-	UNKNOWN		-		
test JV	-	-	-	DSFFSDDF	-	-	UNKNOWN		-		
dclark_wp85	a month ago	-	359377060002...	LL53110007...	-	Legato_LWM2M (HSUPA			ROGERS		
Vincent_AR	2 days ago	-	352767050008...	GM34250030...	AR6220	Legato_LWM2M (UNKNOWN			-		
Giang_AR	2 months ago	-	352767050007...	GM34250021...	-	no_sec_AR8652...	UNKNOWN		-		

- Create and send a data update using the More | Custom Command menu selection

The screenshot shows the AirVantage Monitor interface. The 'mangoh-de...' device is selected, and the 'More' menu is open, showing options like 'Edit', 'Change labels', 'Retrieve data', 'Export data', 'Apply setting (CSV)', 'Custom Command' (selected), 'Send SMS', 'Wake Up', 'Factory reset', 'Send AT Command', and 'Install application'.

Name	Last Comm. d.	Labels	IMEI/ESN	Serial Number	System Type	Firmware	Technology	RSSI	Current Oper...	Ec/lo	Actions
arduino_de...	21 days ago	mangOH Demo	359377060001...	LL52620009...	-	-	UNKNOWN		-		
test JV	-	-	-	DSFFSDDF	-	-	UNKNOWN		-		
dclark_wp85	a month ago	-	359377060002...	LL53110007...	-	Legato_LWM2M (HSUPA			ROGERS		
Vincent_AR	2 days ago	-	352767050008...	GM34250030...	AR6220	Legato_LWM2M (UNKNOWN			-		
Giang_AR	2 months ago	-	352767050007...	GM34250021...	-	no_sec_AR8652...	UNKNOWN		-		
AR8652_RLS	3 months ago	RLS	358464060000...	LS50710071...	-	MDM_SWI9X15A	EDGE		BOUYG		
davidclark	8 months ago	-	355604050001...	-	-	Legato_Beta (1.0	EGPRS		CAN RO		
RMD-TEST...	10 months ago	-	352766050013...	-	-	Legato_Beta (1.0	EGPRS		CAN RO		
AR7_ZB	11 months ago	-	352767050005...	GM33070008...	-	Legato_Beta (1.0	HSDPA+ - HS...		CAN ROGERS		
AR7562-SZ	11 months ago	-	352767050006...	GM33070004...	-	Legato_Beta (1.0	EGPRS		CHN-UNICOM		
AR7554-SZ	10 months ago	-	354917067554...	GN42040019...	-	Legato_Beta (1.0	HSPA		CHN-UNICOM		
AR7554 FNO	a year ago	FNO	352768050030...	GN42320028...	-	Legato_Beta (1.0	LTE		ORANGE F		
alevWin7	a year ago	-	356767050001...	-	-	Legato_Beta (1.0	EGPRS		ROGERS WIR		

- Configure the following Custom Command parameters and then select the Send Command button:
 - Application Model
 - Command
 - Data values

