Hackathon presented by AT&T and 2lemetry

Overview

In this hackathon you will connect an Arduino Leonardo device to a cloud platform in order to transmit sensor values and receive commands. As part of this hackathon you will also interact with the cloud platform via a REST API to query the sensor values published to the platform.

Quick Start

This section provides a streamlined set of steps to get running quickly. The sections that follow this one go into more detail on each of these steps.

1. Setup Arduino IDE
   The Arduino IDE is found at: http://arduino.cc/en/main/software

~~1.~~2. Download library.
   The library can be found here: https://github.com/attM2Mfoundry/hackathon-09-14-2013/tree/master/Arduino3G. Download and setup in Arduino IDE.

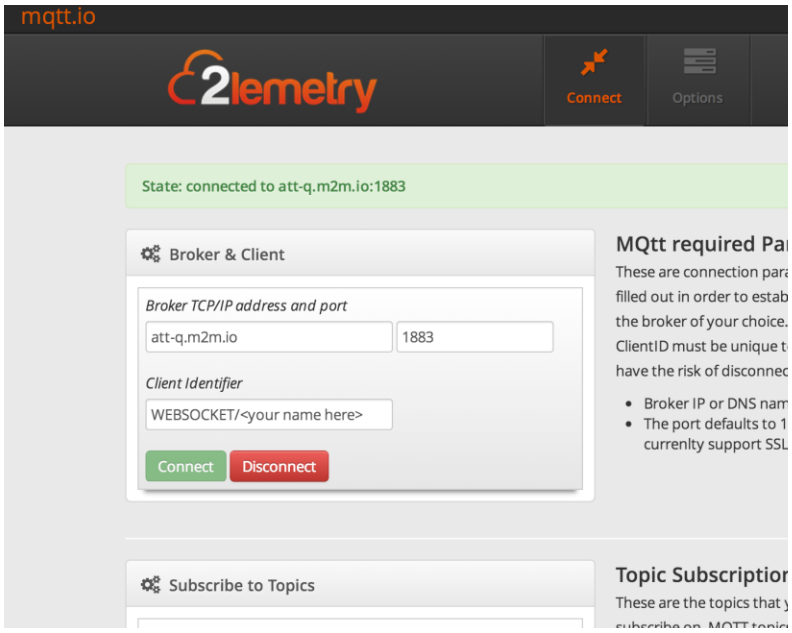
~~2.~~3. Copy example sketch.
   The library includes a couple examples. Copy one of these into a New Sketch. The easiest to start with is the sensor loop. Don't worry at this time about the circuitry as the sketch will send whatever value is read on the analog pin. We're more concerned with connectivity at this point rather than accurate sensor values.

~~3.~~4. Connect Libelium 3G shield to Arduino Leonardo.
   The 3G shield should include an ~~atenna~~arena. This is highly recommended for 3G connectivity. Snap the ~~sheild~~shield on top of the Arduino Leonardo matching pins to connect the two.

~~4.~~5. Connect USB from host computer to Arduino Leonardo (not shield).
   ~~Stanard~~Standard step for Arduino development. The USB cable allows for uploading sketches to the Arduino as well as outputting printed debug/information statements.

~~5.~~6. Connect MQTT client to observe real-time data.

The ATTCloudClient library utilizes MQTT messaging underneath to communicate real-time data with the AT&T message broker. To observe this data while it is being published, connect an MQTT client. A web-based client can be found at http://mqtt.io.



State: connected to att-q.m2m.io:1883

Broker & Client

Broker TCP/IP address and port

att-q.m2m.io 1883

Client Identifier

WEBSOCKET/<your name here>

MQtt required Pa

These are connection para
filled out in order to estab
the broker of your choice.
ClientID must be unique t
have the risk of disconnec

- Broker IP or DNS nam
- The port defaults to 1
  currenlty support SSL

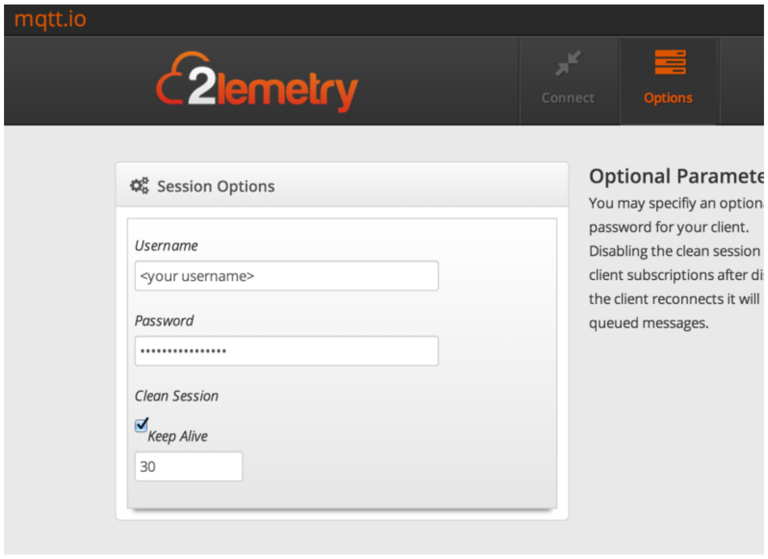
Subscribe to Topics

Topic Subscriptior

These are the topics that y

The MQTT parameters are as follows. Note the username/password are found on the Options tab. These need to be populated before clicking on Connect.

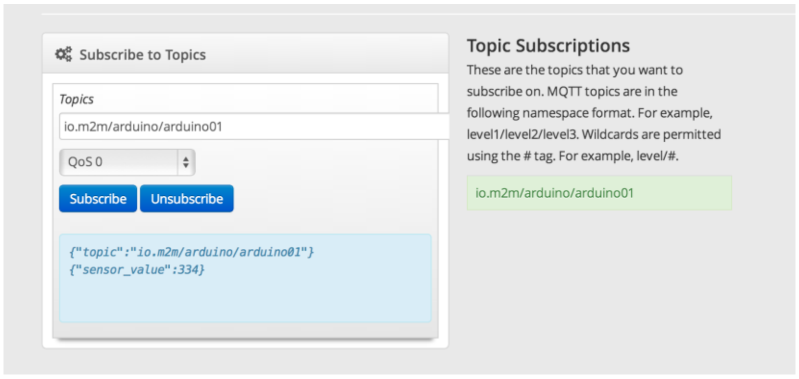
Server: att-q.m2m.io
Port: 1883
Username: Platform username given in the hackathon.
Password: Password assigned at time of the hackathon.



Optional Paramete
You may specifiy an option
password for your client.
Disabling the clean session
client subscriptions after di
the client reconnects it will
queued messages.

Username: <your username>
Password: ••••••••••••••••
Clean Session: ✓
Keep Alive: 30

Once connected, subscribe to the topic <domain>/<device type>/<device ID>. (io.m2m/arduino/arduino01 in this example)



Topics: io.m2m/arduino/arduino01
QoS 0

```
{"topic":"io.m2m/arduino/arduino01"}
{"sensor_value":334}
```

Topic Subscriptions
These are the topics that you want to subscribe on. MQTT topics are in the following namespace format. For example, level1/level2/level3. Wildcards are permitted using the # tag. For example, level/#.

io.m2m/arduino/arduino01

Note: In the portal the term *stuff* is used in place of device type. Likewise the term *thing* is used in the place of device ID.

~~6.~~7. Populate the constants at the beginning of the sketch.
There are a number of constants at the beginning of the sketch. Update them as follows:
USERNAME: <username on AT&T platform>
PASSWORD: <md5 sum of clear text password>

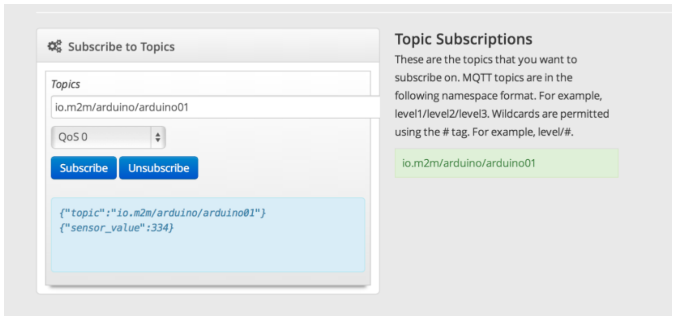
DOMAIN: <Your assigned domain> This can easily be found on the Account tab in the portal.
DEVICE_TYPE: This is an arbitrary string to classify devices into different capability groups.
DEVICE_ID: The unique device in this experimentation / hackathon project.

~~7.~~8. Build & Upload Sketch
Press the Upload button to build and upload the code to the Arduino. When using the Arduino IDE to upload it has been observed that a "serial port in use" error occurs. This sometimes can be eliminated by reselecting the serial port by selecting Tools > Serial Port and then clicking on the proper port. This may already be checked with a check mark. Select it anyway.

~~8.~~9. Open serial monitor
Expected successful behavior is similar to: update with any library changes

```
AT
START
+STIN: 25
+CPIN: READY
AT
ATOK
+VOICEMAIL: INIT_STATE, 0, 0
OK
Connecting to the network...
Connected to network
AT+CGSOCKCONT=1,"IP","m2m.com.attz"
AT+CGSOCKCONT=1,"IP","m2m.com.attz"OK
AT+NETOPEN="TCP"
AT+NETOPEN="TCP"Network opened
Network opened
AT+TCPCONNECT="att-q.m2m.io",1883
AT+TCPCONNECT="att-q.m2m.io",1883Connect ok
AT+TCPWRITE=99
AT+TCPWRITE=99
Loop...
::read timeout
Loop...
::read timeout
Loop...
```

~~9.~~10. Observe real-time data. In the MQTT client you will see sensor values published:



io.m2m/arduino/arduino01

{"topic":"io.m2m/arduino/arduino01"}
{"sensor_value":334}

Topic Subscriptions

These are the topics that you want to subscribe on. MQTT topics are in the following namespace format. For example, level1/level2/level3. Wildcards are permitted using the # tag. For example, level/#.

io.m2m/arduino/arduino01

~~10.~~11. Power Down
Remove USB cable from host computer to power down Arduino and 3G shield.

~~11.~~12. Observe past data in portal

~~12.~~13. Make a past API call to retrieve same data
Below is an example of using the command-line client cURL to query data previously published to the platform:

```
curl –user <user name>:<password>
http://att-api.m2m.io/2/account/domain/mydomain/stuff/mythings/thing/thing001/past?attributes=
```

And an example response:

```
{
  "domain": "mydomain",
  "stuff": "mythings",
  "thing": "thing001",
  "lastentry": "1369518276118890",
  "results": {
    "1369592198946353": {
      "sensor_value": 100
    },
    "1369592187210084": {
      "sensor_value": 101
    },
    "1369592182612328": {
      "sensor_value": 99
    },
    "1369590782704041": {
      "sensor_value": 22
    },
    "1369590779565053": {
      "sensor_value": 23
    },
    "1369518276118890": {
      "sensor_value": 25
    }
```

```
        }
    }
```

AT&T Arduino Library

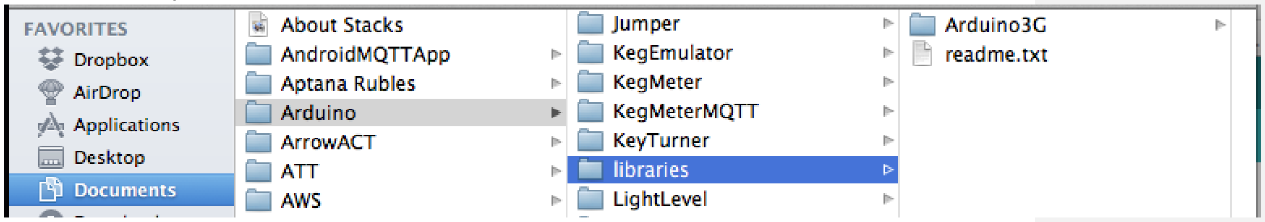
An Arduino library has been created for this hackathon that allows easy connection of the Arduino to the cloud. This library abstracts the underlying messaging protocol and allows easy publishing of a variety of key/value pairs.

Setup of Library

The library repo can be cloned from here:
https://github.com/attM2Mfoundry/hackathon-09-14-2013/tree/master/Arduino3G
~~http://path.to.att.gihub/3GClient.git~~

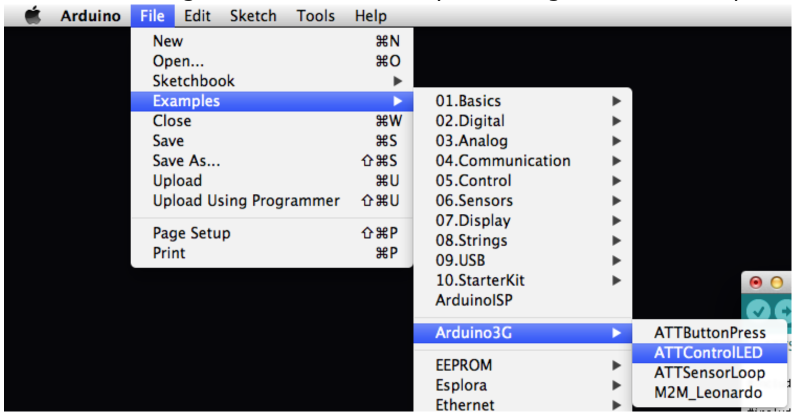
Instructions to setup an Arduino library can be found at http://arduino.cc/en/Guide/Libraries.

Location of libraries (Arduino IDE 1.0.1 and greater) is in the Documents/MyDocuments folder:



Examples Included in Library

The library comes with a few examples to help you get started quickly. These can be found through the Arduino IDE by selecting: File > Examples > ATTCloudClient:



Including library in sketch:

```
#include <ATTCloudClient.h>
```

The following is an overview of a few of the key methods provided by the ATTCloudClient.

The following references are required. The first is the CloudClient object which provides the messaging functionality. The second is the driver interface for the Arduino 3G shield.

```
ATTCloudClient acc;
ATT3GModemClient c;
```

The following two lines instantiate the client and perform the connection to the cloud server. More information on the constants in these methods can be found below. When instantiating the client, a callback method is given. This method is defined in the user's sketch and handles processing of commands received from the cloud server.

```
 acc = ATTCloudClient(cmdCallBack,c);
 acc.connect(M2MIO_DEVICE_ID,M2MIO_USERNAME,M2MIO_PASSWORD)
```

This method configures the cloud client to use the user's messaging space (domain). More information on the constants can be found below.

```
acc.setDomainStuffThing(M2MIO_DOMAIN,M2MIO_DEVICE_TYPE,M2MIO_DEVICE_ID);
```

The following method sends a key-value pair to the cloud store. There are many methods for sending values which can be found in the ATTCloudClient reference provided.

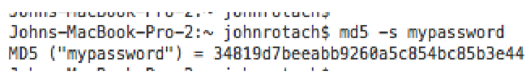
```
acc.sendKV("sensor_val", sensorValue);
```

At the beginning of the example sketches you will see a series of constants which configure things such as username and password for the cloud server.

```
M2MIO_USERNAME[]    = "<username>";
M2MIO_PASSWORD[]    = "<MD5 sum of password (32 characters)>";
M2MIO_DOMAIN[]       = "<domain>;
M2MIO_DEVICE_TYPE[]  = "<device type>";
M2MIO_DEVICE_ID[]    = "<device ID>";
```

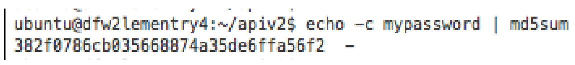
USERNAME: The username on the AT&T M2M platform. This will be supplied to you as part of the hackathon materials.
PASSWORD: The password on the AT&T M2M platform. This will be supplied to you as part of the hackathon materials. When using it in the Arduino sketch, the password is the MD5 hash of the clear-text password. This will be a 32 character value. MD5 hashes can be found by running local tools:

OSX:



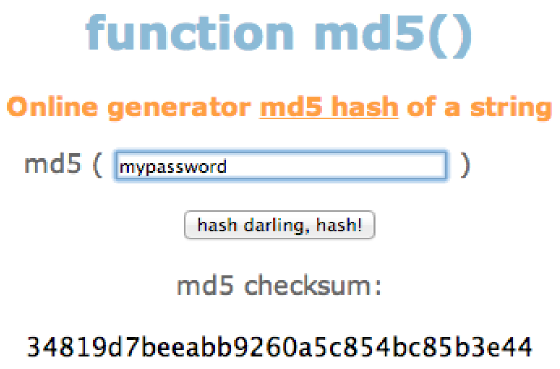
```
Johns-MacBook-Pro-2:~ johnrotach$ md5 -s mypassword
MD5 ("mypassword") = 34819d7beeabb9260a5c854bc85b3e44
```

Linux:



```
ubuntu@dfw2lementry4:~/apiv2$ echo -c mypassword | md5sum
382f0786cb035668874a35de6ffa56f2  -
```

Or by using an online MD5 hash generator at: http://www.md5.cz. ~~online MD5 hash generator.~~



```
34819d7beeabb9260a5c854bc85b3e44
```

The messaging space on the AT&T cloud platform is separated by three parameters: domain, device type and device ID. Each account has an associated domain. Under that domain there can be many device types and likewise under each device type many devices can be given. A simple example may help illustrate this concept.

Suppose you have around 100 devices which measure temperature and report the values back to the platform. Some are Arduinos, some are Raspberry Pis and some are PCs. All off these devices would report on the same domain. All of the Arduinos would report on their device type under their respective device ID.

```
Domain    /  Device Type / Device ID
<domain> / arduinos / arduino01
<domain> / arduinos / arduino02
<domain> / arduinos / arduino02
<domain> / pc / pc01
<domain> / pc / pc02
<domain> / pc / pc03
<domain> / pc / pc04
```

DOMAIN: The user’s domain on the AT&T platform.

DEVICE TYPE: The type of device. This is an arbitrary field to separate devices into smaller buckets by type. For this hackathon using the value "arduino" makes sense.
DEVICE ID: A unique name for each device reporting. This can be something arbitrary such as "arduino01" as long as it is unique across your domain.

Sending Values to the Cloud Platform

The messaging protocol that underpins the ATTCloudClient is MQTT. MQTT provides a simple publish/subscribe architecture. For the most part in this hackathon the underlying MQTT protocol is abstracted away and in its place methods are provided to send key-value pairs to the platform.

The following two examples show two ways to send values to the platform. The first involves sending one key-value pair:

```
acc.sendKV("sensor_val", sensorValue);
```

This sends the key "sensor_val" and its respective value, the integer value stored in sensorValue. This example would be useful if the device implemented a single sensor and only needed to send a periodic update of the value.

Another example involves building a message containing multiple key-value pairs:

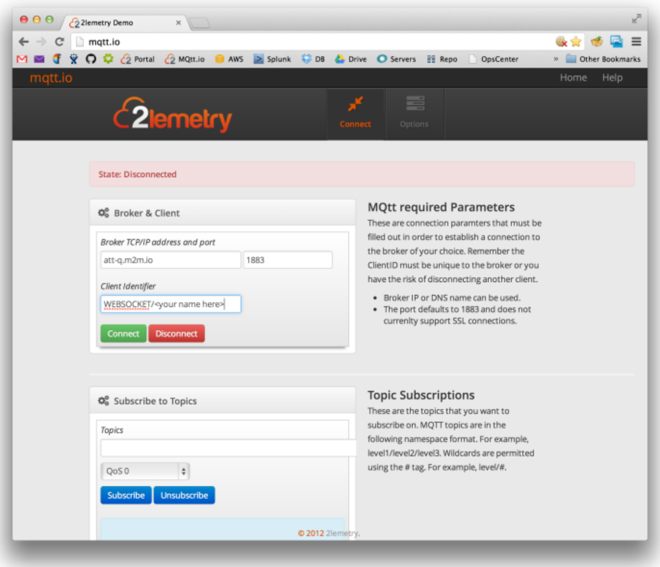
```
acc.startMessage();
acc.addKVToMessage("value1",1);
acc.addKVToMessage("value2",22);
acc.addKVToMessage("value3",333);
acc.endMessage();
acc.sendMessage();
```

The message is created and sent by calling startMessage, adding KV pairs, ending the message by calling endMessage and then sending the message. As the message being created is built inside the library this series of calls must be executed in the above order. From 1 to 5 K-V pairs can be added to a message.

Sending Commands to the Device from the Cloud Platform

The ATTCloudClient library also provides the ability to register to receive commands from the cloud platform. The ATTControlLED example included with the library shows receiving a "light on" / "light off" command and turning on or off an LED according to the command received.

To send a command from the cloud platform, navigate to http://mqtt.io. Login by using the following parameters (the same as real-time above):



State: Disconnected

Broker TCP/IP address and port: att-q.m2m.io 1883

Client Identifier: WEBSOCKET/<your name here>

MQtt required Parameters

These are connection paramters that must be filled out in order to establish a connection to the broker of your choice. Remember the ClientID must be unique to the broker or you have the risk of disconnecting another client.

- Broker IP or DNS name can be used.
- The port defaults to 1883 and does not currenlty support SSL connections.

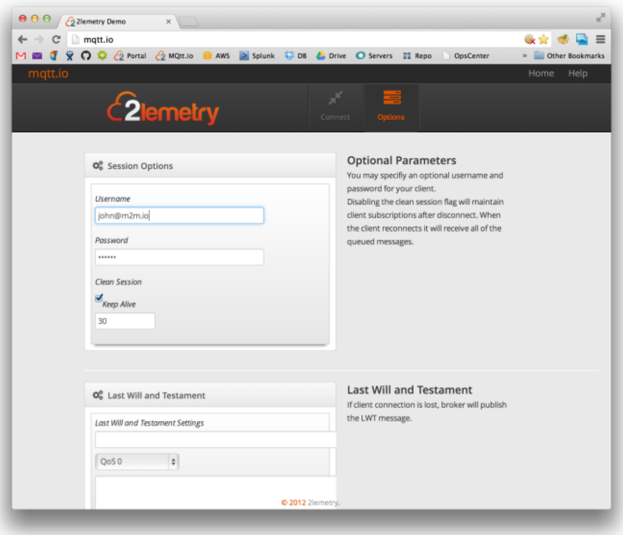
Topics:

QoS 0

Topic Subscriptions

These are the topics that you want to subscribe on. MQTT topics are in the following namespace format. For example, level1/level2/level3. Wildcards are permitted using the # tag. For example, level/#.

Click on the Options tab to input your username / password. Do this before clicking on Connect.



Username: john@m2m.io

Password: ••••••

Clean Session: ✓

Keep Alive: 30

Optional Parameters

You may specifiy an optional username and password for your client.
Disabling the clean session flag will maintain client subscriptions after disconnect. When the client reconnects it will receive all of the queued messages.

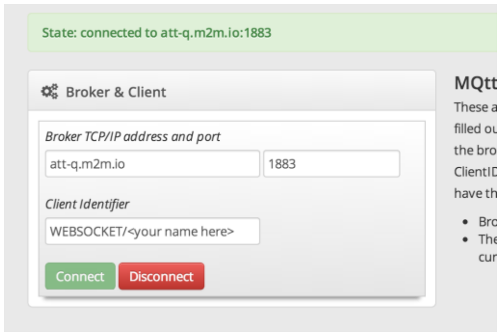
Last Will and Testament Settings

QoS 0

Last Will and Testament

If client connection is lost, broker will publish the LWT message.

After entering your credentials, click on Connect. You should see the green Connected bar appear:

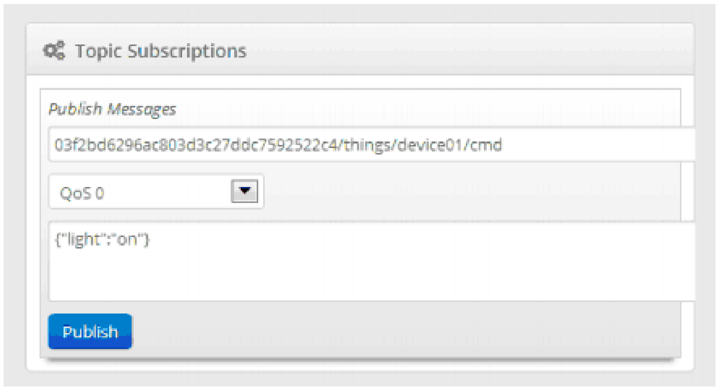

State: connected to att-q.m2m.io:1883

Broker & Client

Broker TCP/IP address and port: att-q.m2m.io 1883

Client Identifier: WEBSOCKET/<your name here>

Every device is setup by the library to publish on the MQTT topic <domain>/<device type>/<device ID>. For commands a /cmd topic level is appended: <domain>/<device type>/<device ID>/cmd. To publish a command to the device, use "Topic Publish".


Topic Subscriptions

Publish Messages

03f2bd6296ac803d3c27ddc7592522c4/things/device01/cmd

QoS 0

{"light":"on"}

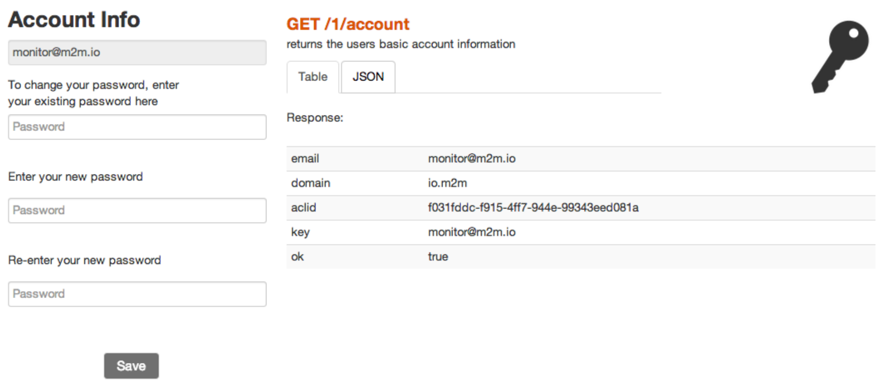
API

The REST API can be found hosted at the following URL: http://att-api.m2m.io. Note this is the base URL for the API, and cannot be accessed as a regular web site. Detailed documentation on API calls can be found in the API reference document supplied in the hackathon documentation.

Portal

There is a portal that allows a graphical interface to the REST API. It can be found at: http://att.m2m.io. To login to the portal use your username and password (not MD5) for the platform.

Account - The account tab provides information about your platform account. This is where your domain can be looked up and copied.



Account Info

monitor@m2m.io

To change your password, enter your existing password here

Password

Enter your new password

Password

Re-enter your new password

Password

Save

GET /1/account

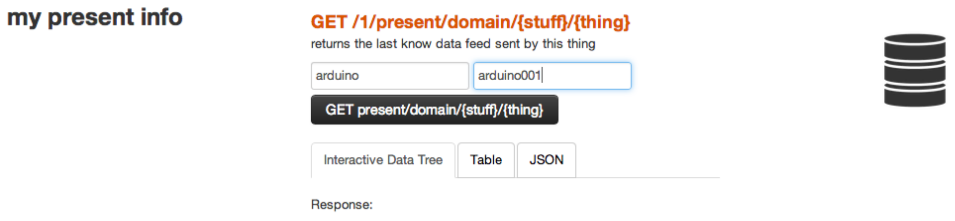
returns the users basic account information

Table | JSON

Response:

email	monitor@m2m.io
domain	io.m2m
aclid	f031fddc-f915-4ff7-944e-99343eed081a
key	monitor@m2m.io
ok	true

Present - A present call returns the <u>most recently</u> published value. This is a good way to retrieve the current value of a sensor when building an application. When the desired query parameters have been populated, click on the black button (w/API reference) to execute API call.



my present info

GET /1/present/domain/{stuff}/{thing}

returns the last know data feed sent by this thing

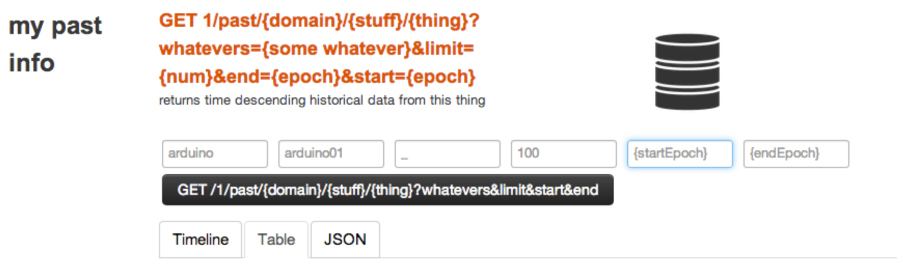
arduino | arduino001

GET present/domain/{stuff}/{thing}

Interactive Data Tree | Table | JSON

Response:

Past - A past call is used to lookup past sensor values published to the platform. In the portal stuff = device type and thing = device ID. In the whatevers field, an _ is a wildcard for all values. When the desired query parameters have been populated, click on the black button (w/API reference) to execute API call.



my past info

GET 1/past/{domain}/{stuff}/{thing}?whatevers={some whatever}&limit={num}&end={epoch}&start={epoch}

returns time descending historical data from this thing

arduino
arduino01
_
100
{startEpoch}
{endEpoch}
GET /1/past/{domain}/{stuff}/{thing}?whatevers&limit&start&end
Timeline
Table
JSON

Note: Data will not appear in the portal until after the device has been connected and publishing on a previous occasion.

Note: Registered Device tab in portal is unused in this hackathon scenario.

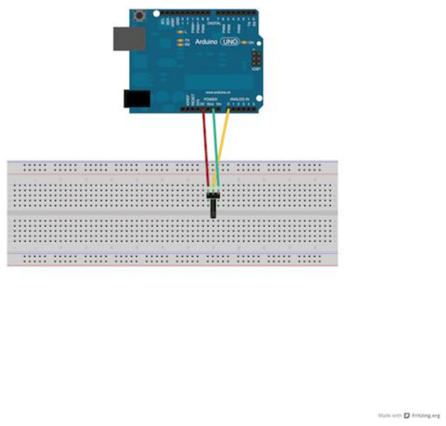
Examples

There are two example sketches provided with the ATTCloudClient. The following section shows the circuits used in these examples.

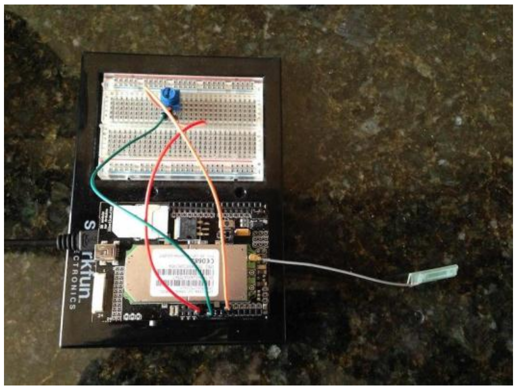
Sensor Loop

In this example a sensor value is repeatedly read and published to the platform. A potentiometer is used to simulate a sensor whose output is voltage.

Schematic



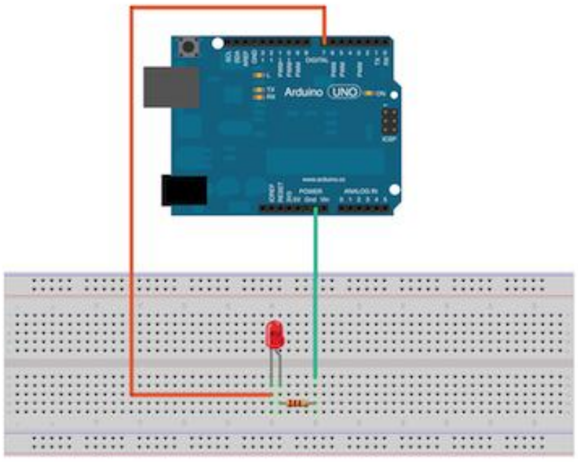
Picture



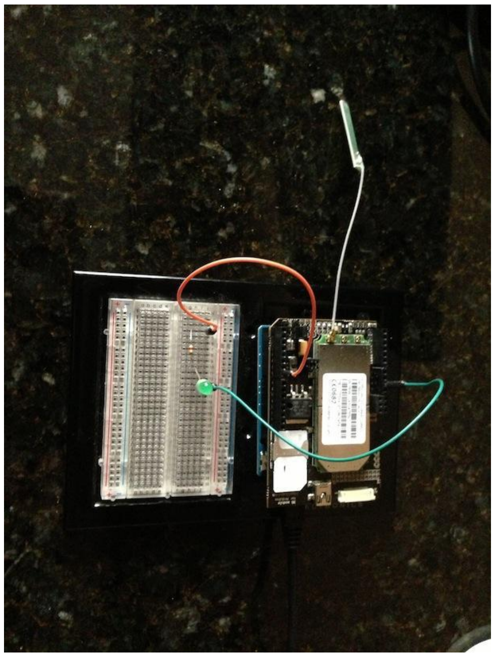
LED

This example shows the device responding to commands from the server. It will turn on/off the LED ~~based on~~based on the content of the "light" command.

Schematic



Picture



Useful Links:

More information on the 3G Shield, including examples for HTTP, TCP, etc.:

http://www.cooking-hacks.com/index.php/documentation/tutorials/arduino-3g-gprs-gsm-gps

Curl utility – useful for testing REST from command line:

http://curl.haxx.se/dlwiz/

Formatted: No Spacing