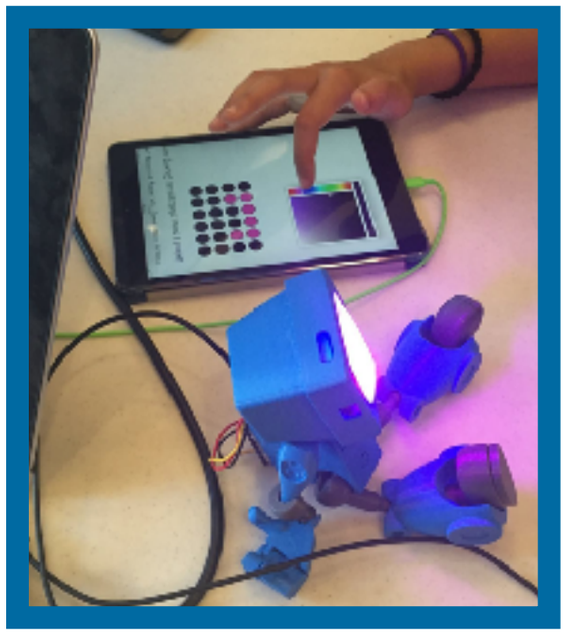
Making IoT: An Intro for Web Devs

Kristina Durivage
@gelicia

About Me

Day Job: **Senior Front End Engineer** at **SmartThings** (Owned by Samsung)

Hobby: **Building light up stuff** and **fun electronics projects!**



@gelicia

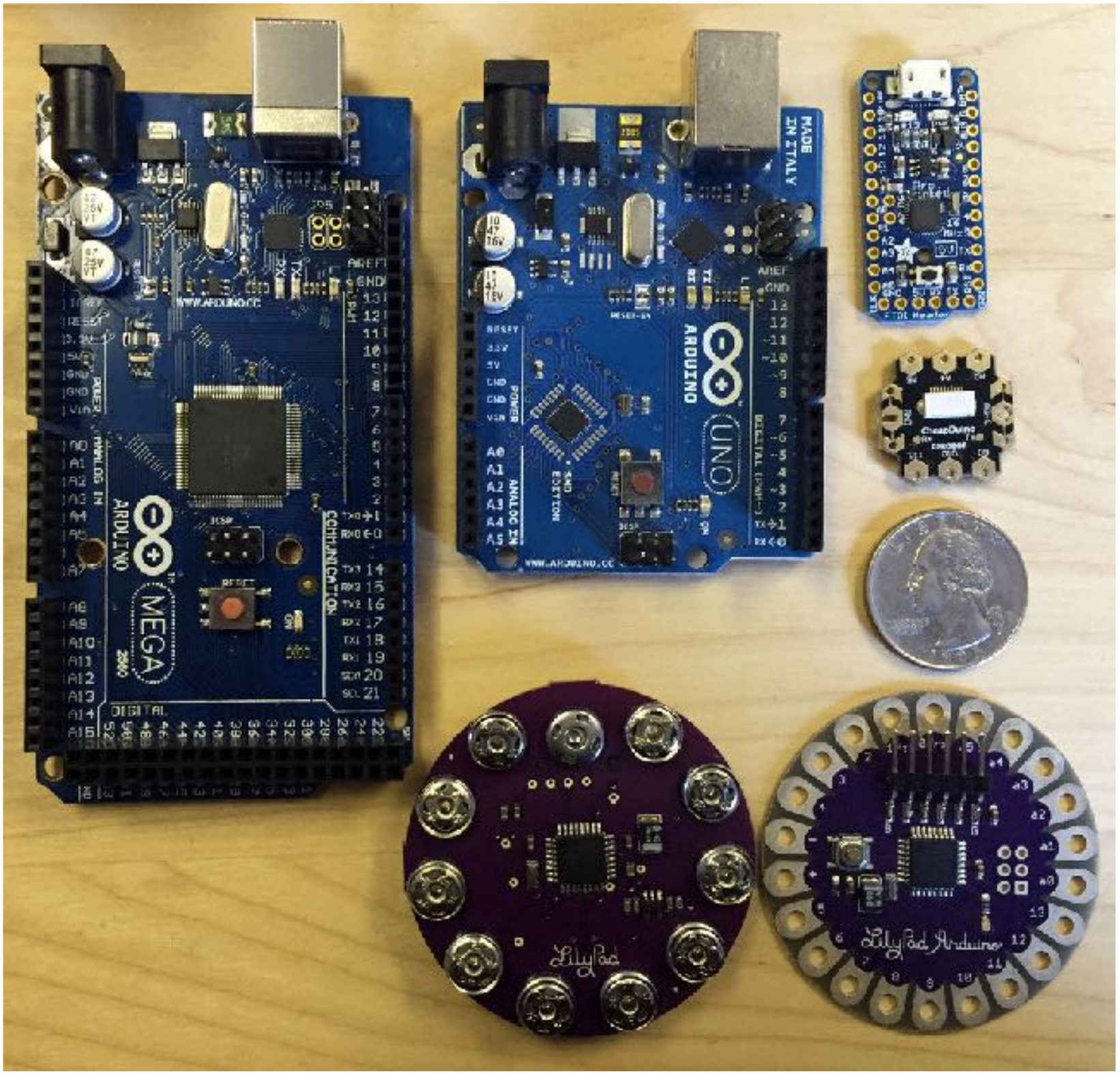
twilio
CLOUD COMMUNICATIONS

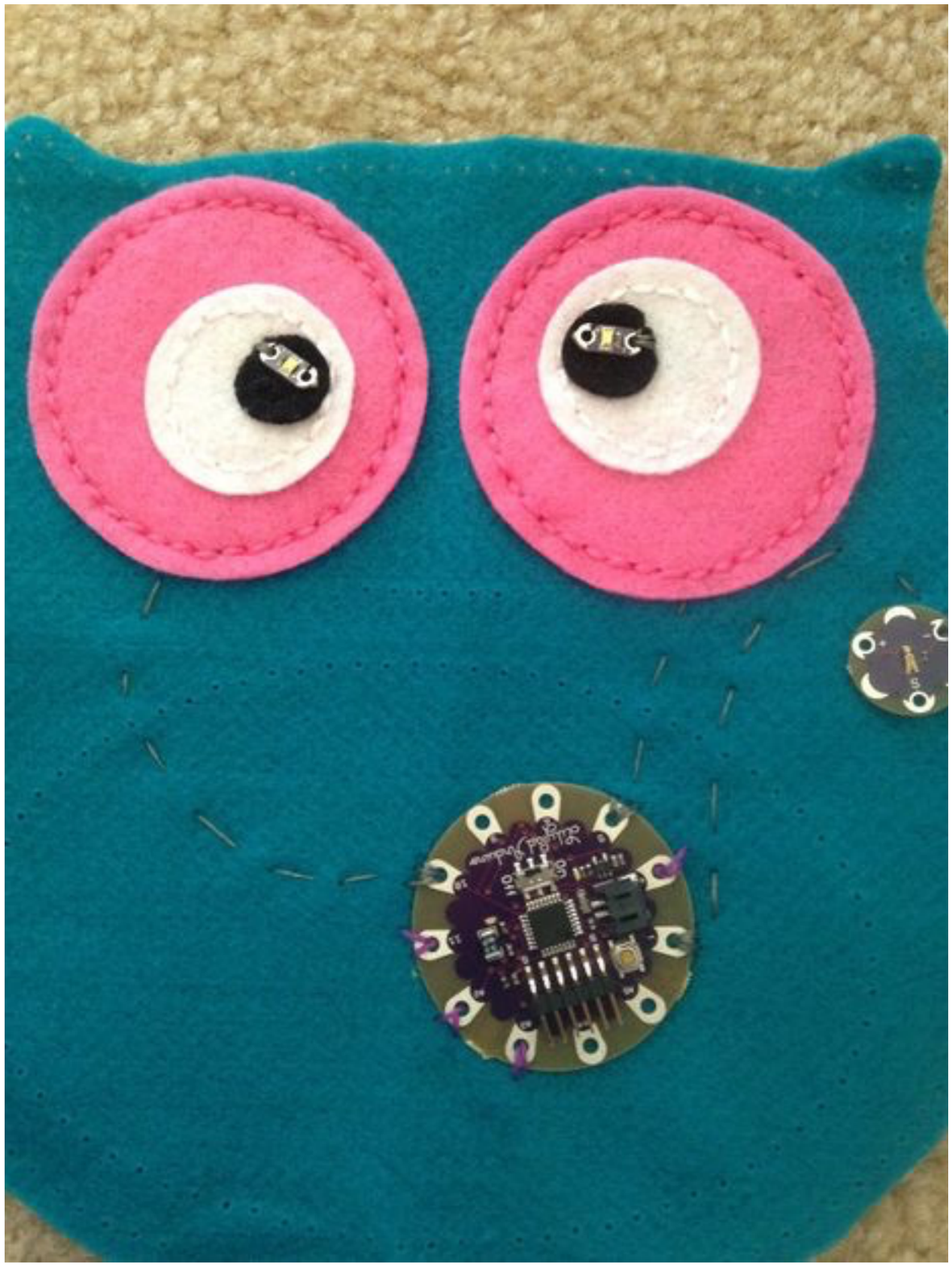
Server

Server

@gelicia

Sash Demo


MADE IN ITALY
ARDUINO
UNO
MEGA
LilyPad
LilyPad Arduino



http://www.instructables.com/id/Athena-the-Owl-Pillow-Nightlight-Lilypad-Arduino/?ALLSTEPS

Hardware Code Basics

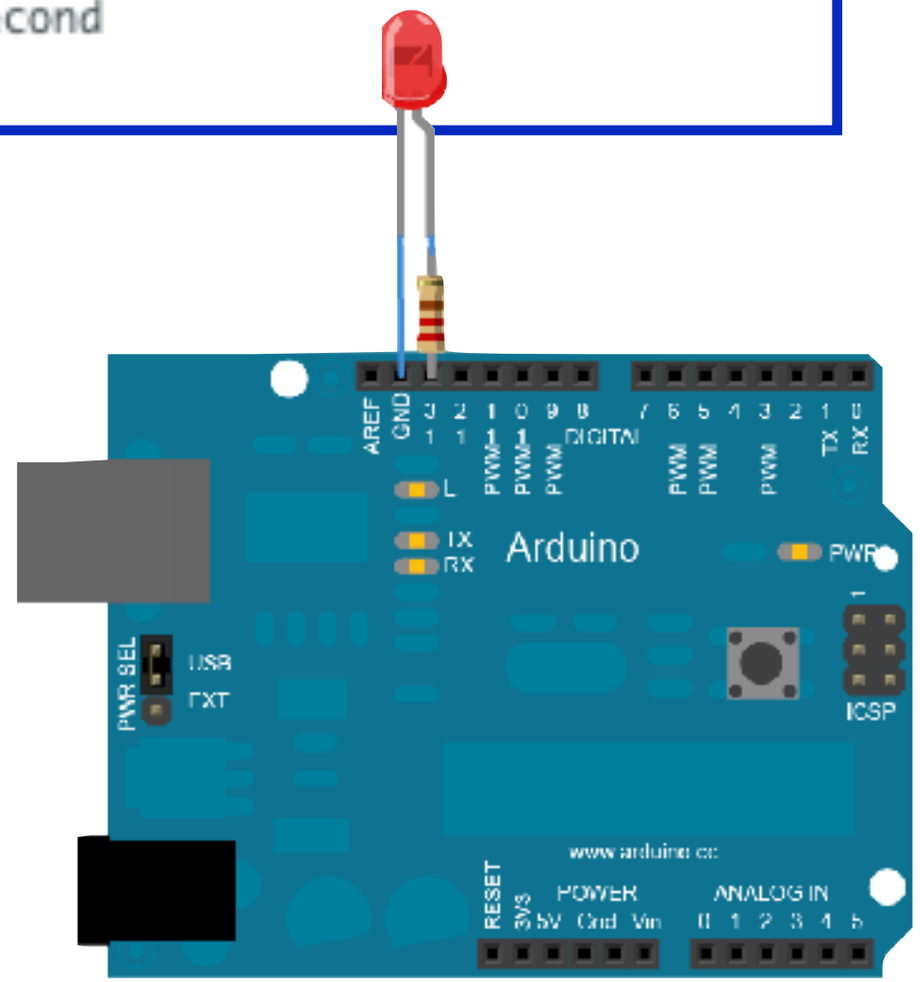
```
1  void setup() {
2
3  }
4
5  void loop() {
6
7  }
```

`setup` - runs once when the micro controller gets power

`loop` - runs continuously

```ino
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  // LED_BUILTIN is D13 on the Uno
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```



Servo for spinning clock hand

10 LEDs for indicating steps

4 touch sensors for determining vegetable

Switch for water

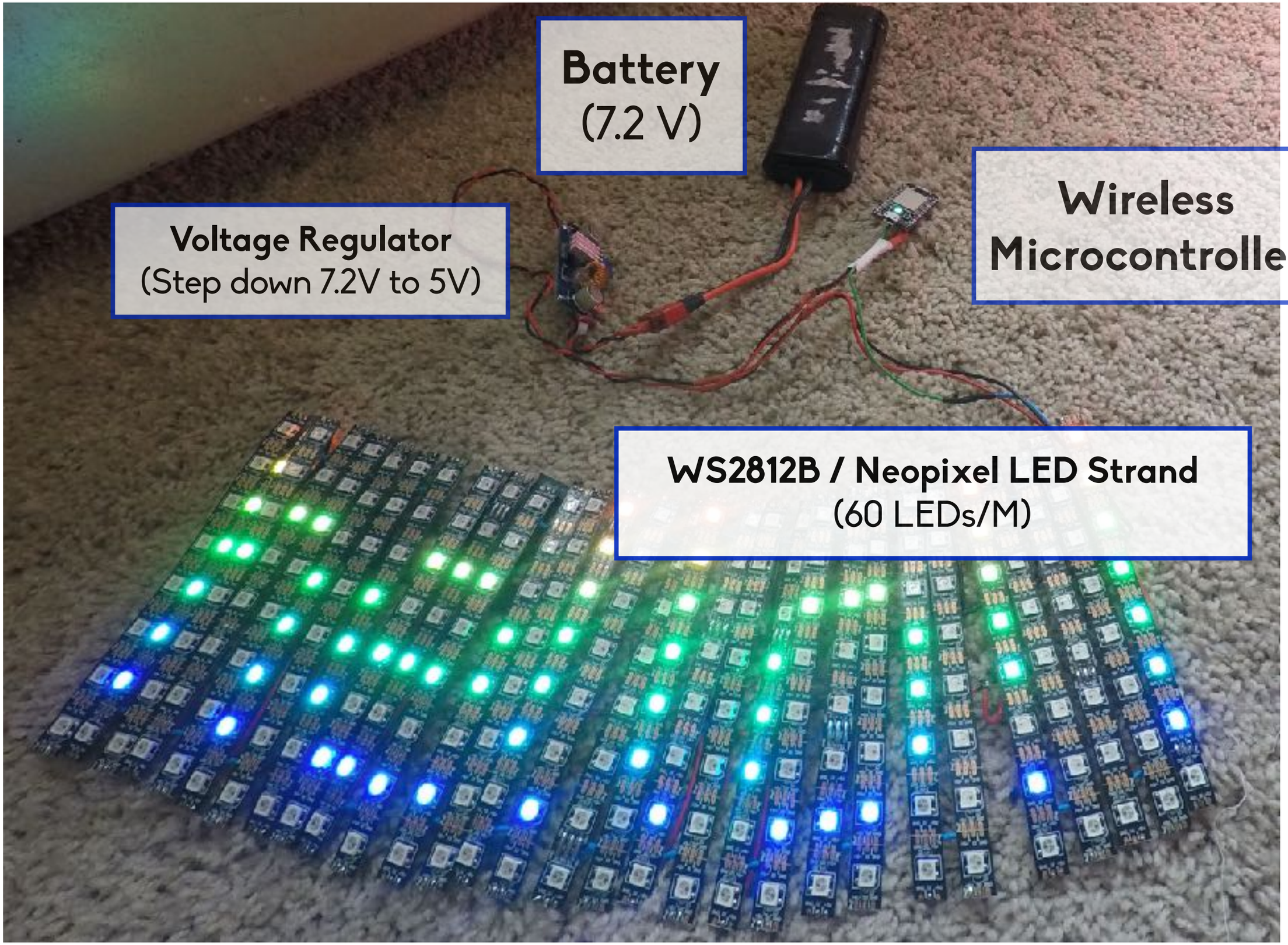
Potentiometer for knowing knob position

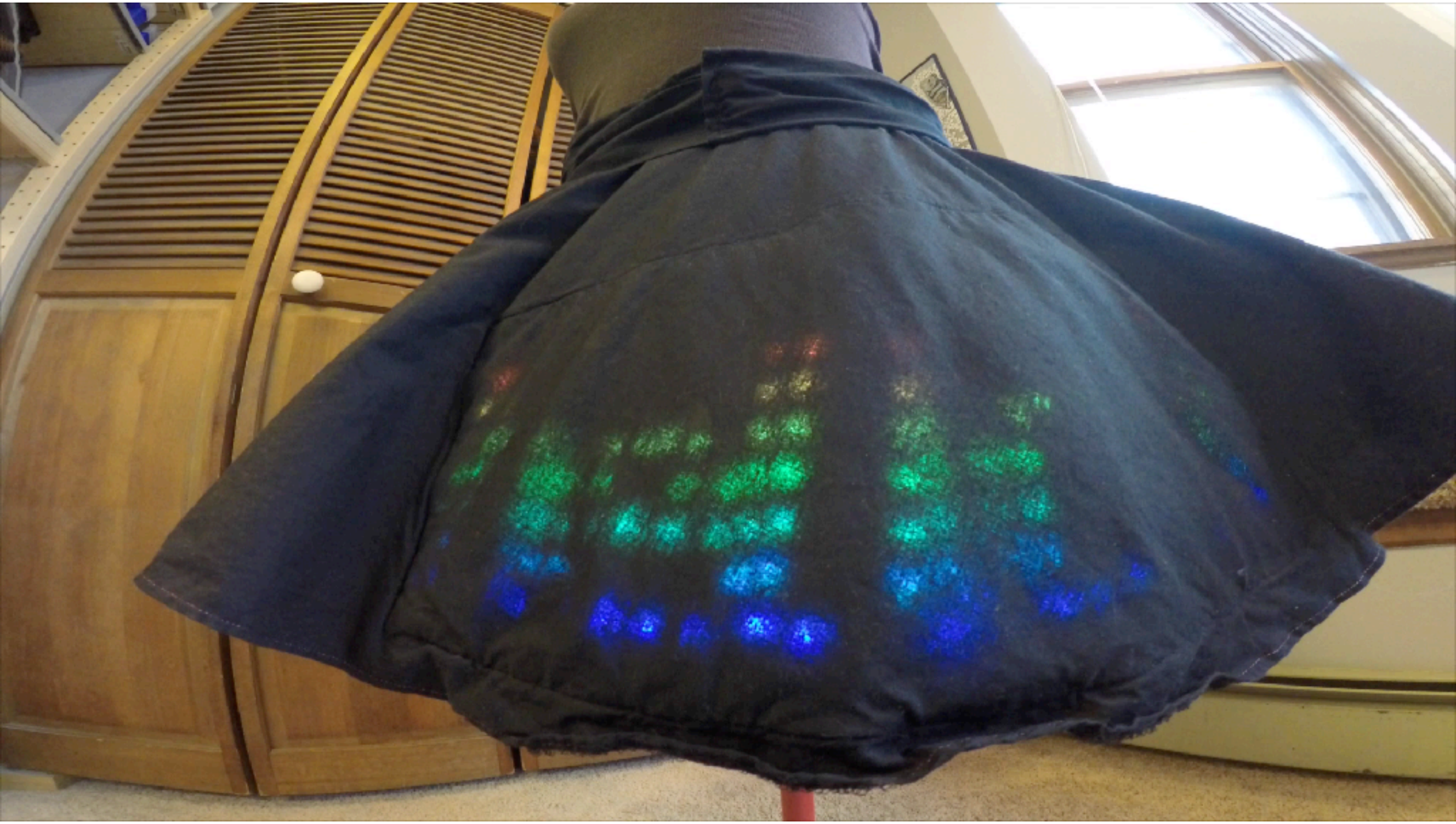
Arduino (Mega) to control

- 7 LEDs
- Arduino (Nano)
- Battery Pack
- Voltage Regulator

Kristina Durivage They need to make a really thin wireless card that I can put in my skirt so it can display tweets (this is actually probably a very bad idea)

November 12, 2012 at 7:59pm · Unlike · 1


Battery
(7.2 V)
Voltage Regulator
(Step down 7.2V to 5V)
Wireless
Microcontroller
WS2812B / Neopixel LED Strand
(60 LEDs/M)



Particle

- **Photon** (WiFi)
- **Electron** (Cellular)
- Argon/Boron/Xenon (Mesh)
  (Mesh = creating a network other devices can join)

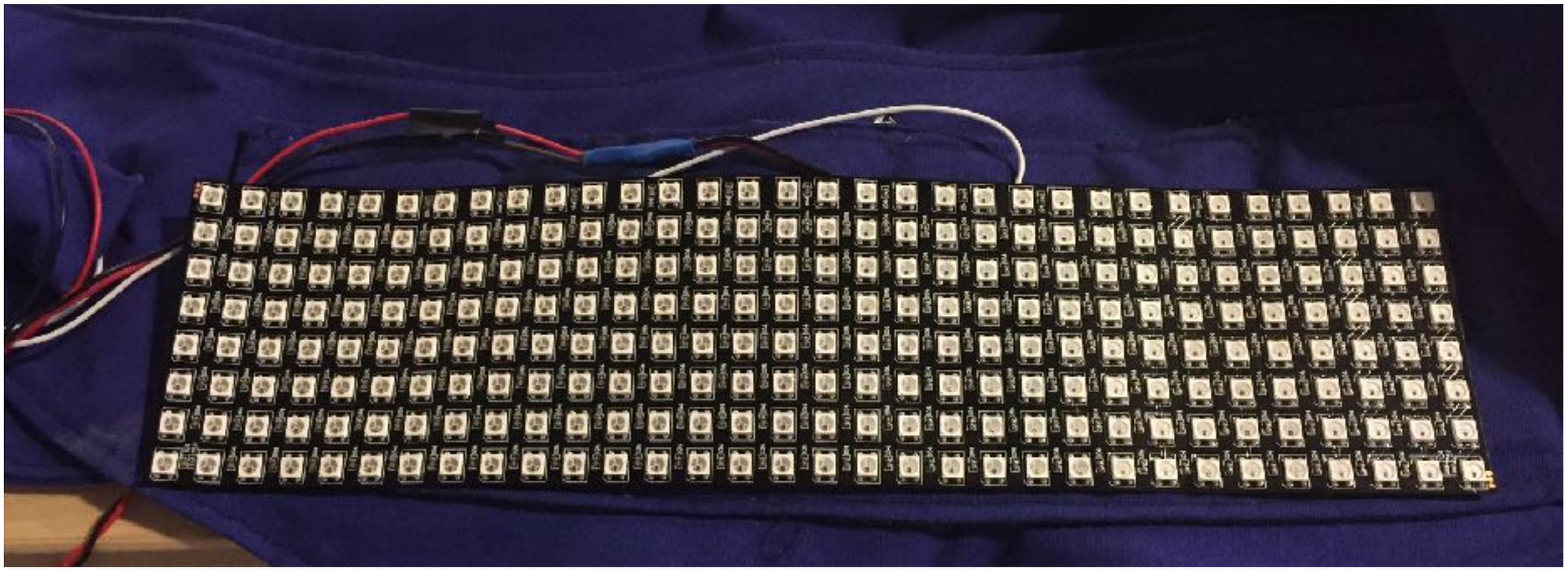
A Photon is **kr 175,42**
(available from Mouser Electronics)

All devices **let you access the Particle cloud** to handle sending/receiving messages from a device

For cheaper alternatives, see ESP8266 or ESP32

Neopixels

- WS2812 / WS2812B / WS2811
- Sequins / Pixels / Board / Module
- Variety of forms, some prewired



Neopixels

- WS2812 / WS2812B / WS2811
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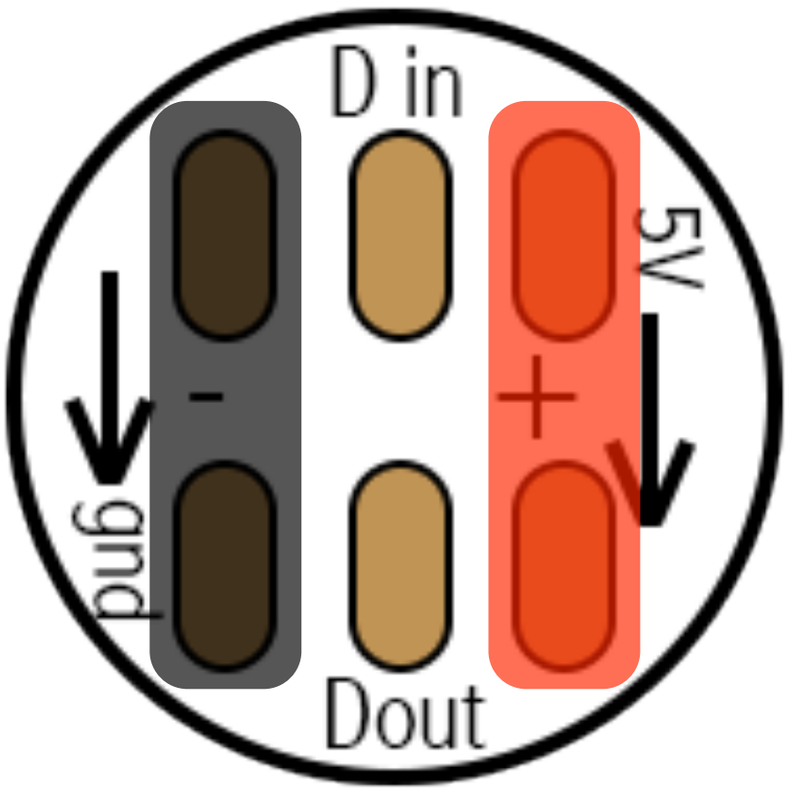
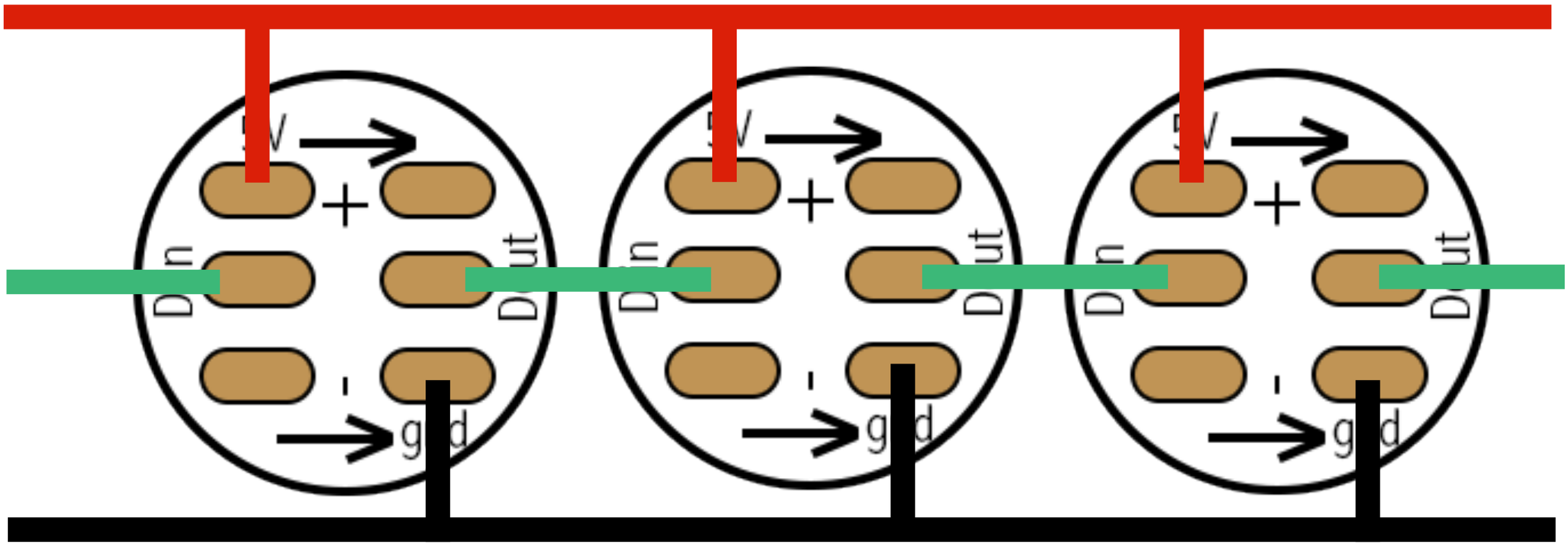
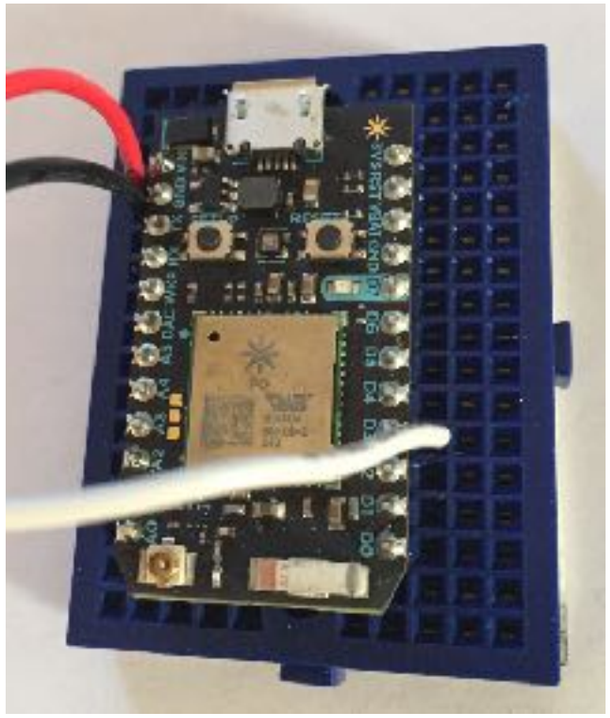


- LEDs need three things:
  - Power
  - Ground
  - Data
- Power and ground don't have a direction


5V
Din
Dout
gnd

Soldering Demo



- Red to VIN
- Black to GND
- Data to D3

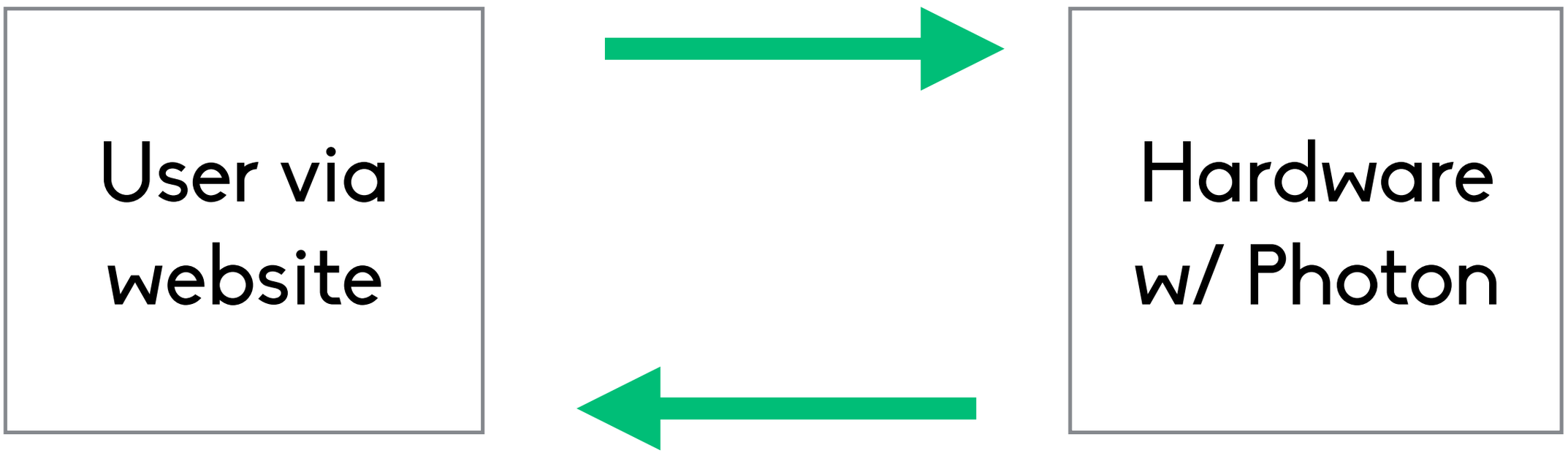
"When the Photon is powered via the USB port, this pin will output a voltage of approximately 4.8VDC"

```
// This #include statement was automatically added by the Particle IDE.
#include <neopixel.h>

Adafruit_NeoPixel strip = Adafruit_NeoPixel(1, D3, WS2812);

void setup() {
    strip.begin();
}

void loop() {
    displayColor();
}

void displayColor(){
    strip.setPixelColor(0, 0, 0, 255); //set LED 0 to blue
    strip.show();
}
```

Particle Cloud API

`Particle.function()`

Allows users to send commands to hardware



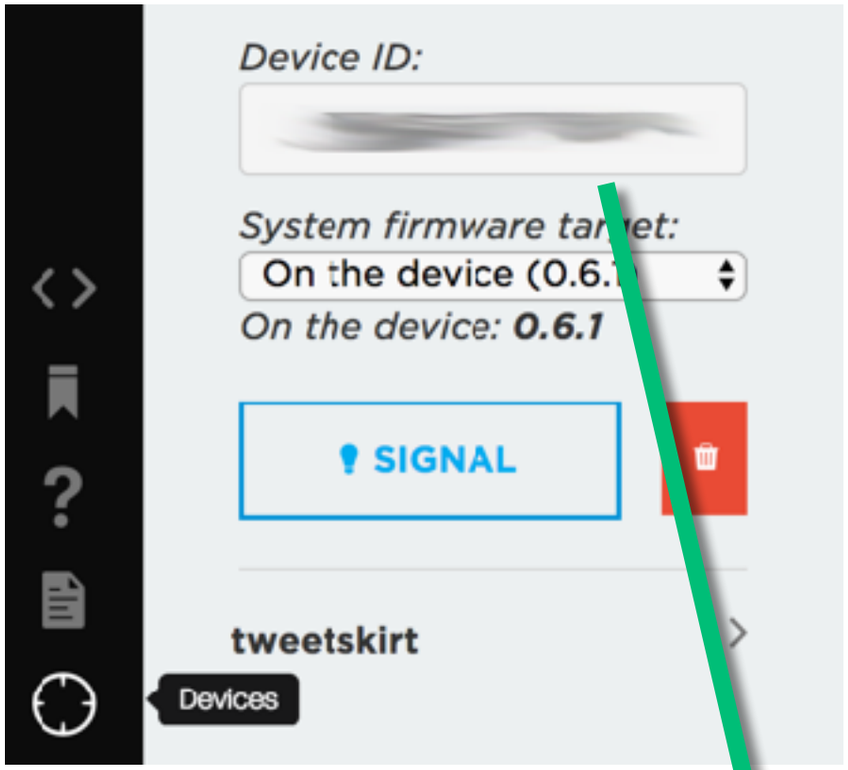
`Particle.variable()`

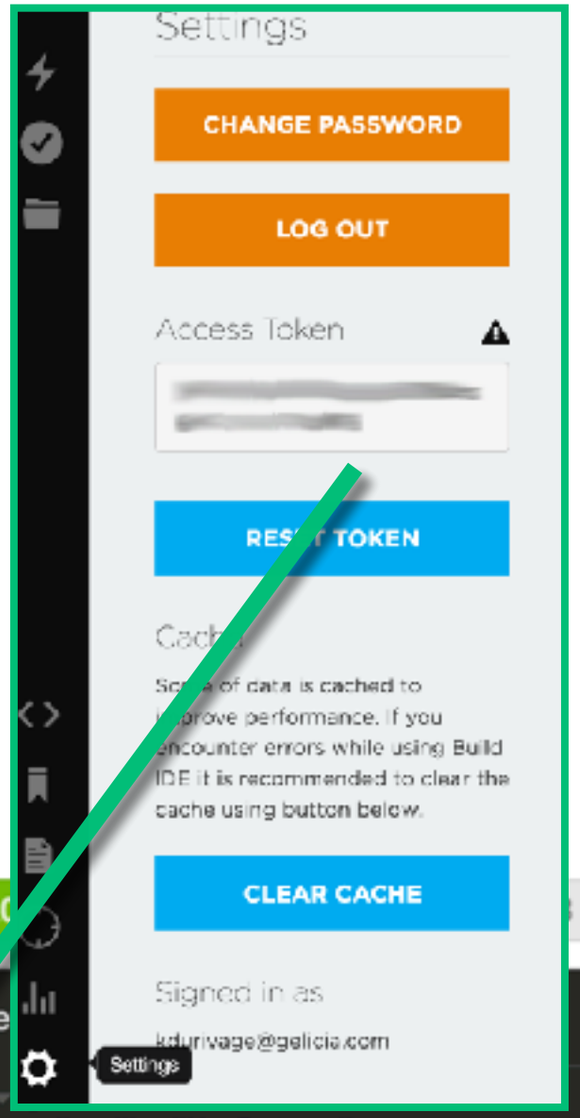
Allows Photon to expose variable to be seen on demand

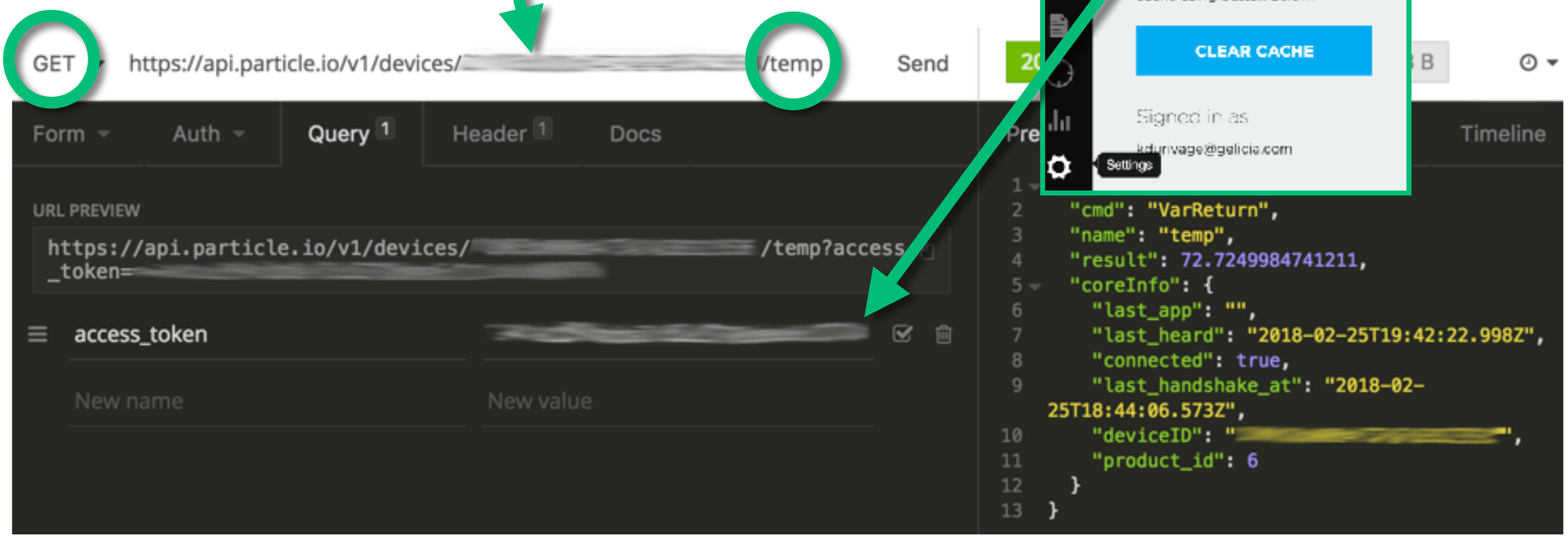
Particle.variable

```
26  Adafruit_NeoPixel strip = Adafruit_NeoPixel(L
27
28  void setup() {
29    Serial.begin(115200);
30    strip.begin();
31    Particle.variable("temp", fahrenheit);
32    Particle.function("setLED", setLED);
33  }
34
```

https://docs.particle.io/reference/firmware/photon/#particle-variable-


Device ID:
System firmware target:
On the device (0.6.1
On the device: 0.6.1
SIGNAL
tweetskirt
Devices


Settings
CHANGE PASSWORD
LOG OUT
Access Token
TOKEN
CLEAR CACHE
Signed in as
Settings


GET
https://api.particle.io/v1/devices/
/temp
Send
Form
Auth
Query 1
Header 1
Docs
Timeline
URL PREVIEW
https://api.particle.io/v1/devices/
/temp?access_token=
access_token
New name
New value
{
"cmd": "VarReturn",
"name": "temp",
"result": 72.7249984741211,
"coreInfo": {
"last_app": "",
"last_heard": "2018-02-25T19:42:22.998Z",
"connected": true,
"last_handshake_at": "2018-02-25T18:44:06.573Z",
"deviceID": "
"product_id": 6
}
}

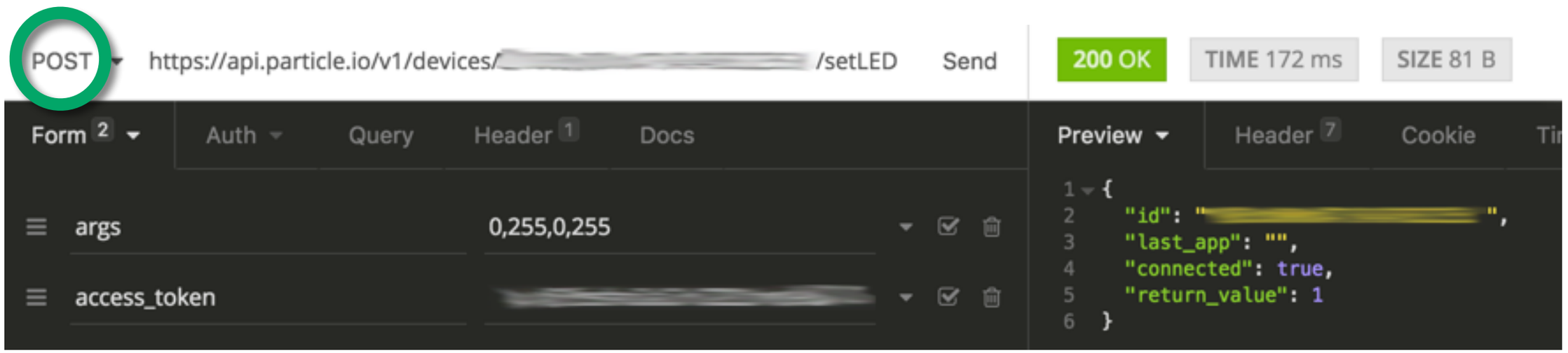
Particle.function

```
26  Adafruit_NeoPixel strip = Adafruit_NeoPixel(L
27
28  void setup() {
29    Serial.begin(115200);
30    strip.begin();
31    Particle.variable("temp", fahrenheit);
32    Particle.function("setLED", setLED);
33  }
```

```
int setLED(String command){
    // Get the index of the ending of these values by starting the index look up after preceeding comma
    int idxEnd = command.indexOf(',');
    int redEnd = command.indexOf(',', idxEnd+1);
    int grnEnd = command.indexOf(',', redEnd+1);
    int bluEnd = command.indexOf(',', grnEnd+1);

    // Use the above end positions to get substrings of the values out of the entire string
    int idx = command.substring(0, idxEnd).toInt();
    int red = command.substring(idxEnd+1, redEnd).toInt();
    int grn = command.substring(redEnd+1, grnEnd).toInt();
    int blu = command.substring(grnEnd+1, bluEnd).toInt();
    Particle.publish("ledCmd", String(idx) + " " + String(red) + " " + String(grn) + " " + String(blu), PRIVATE);

    Serial.println(command + " " + String(idx) + " " + String(red) + " " + String(grn) + " " + String(blu));

    //Some LEDs are RGB, some are GRB. The arduino library lets you define this, but the particle one doesnt, so we
    strip.setPixelColor(idx, strip.Color(grn, red, blu));
    strip.show();
    return 1;
}
```

https://docs.particle.io/reference/firmware/photon/#particle-function-

Particle.function



Variable / Function

Demo

App Demo

IOT Method #1

Continuously Running

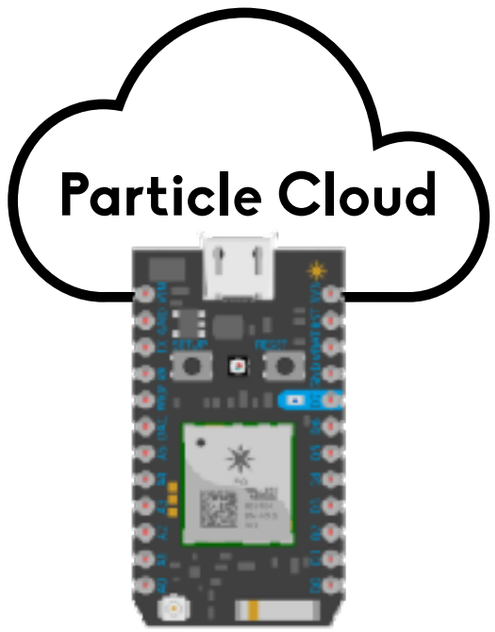
API of choice
(Twitter, Twilio)

Node Process

?

Queued Messages

Displayed Messages



API of choice
(Twitter, Twilio)

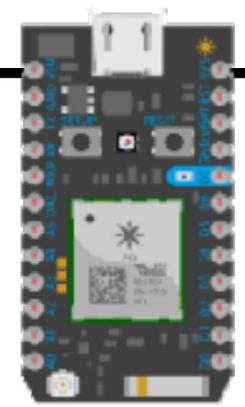
Node Process

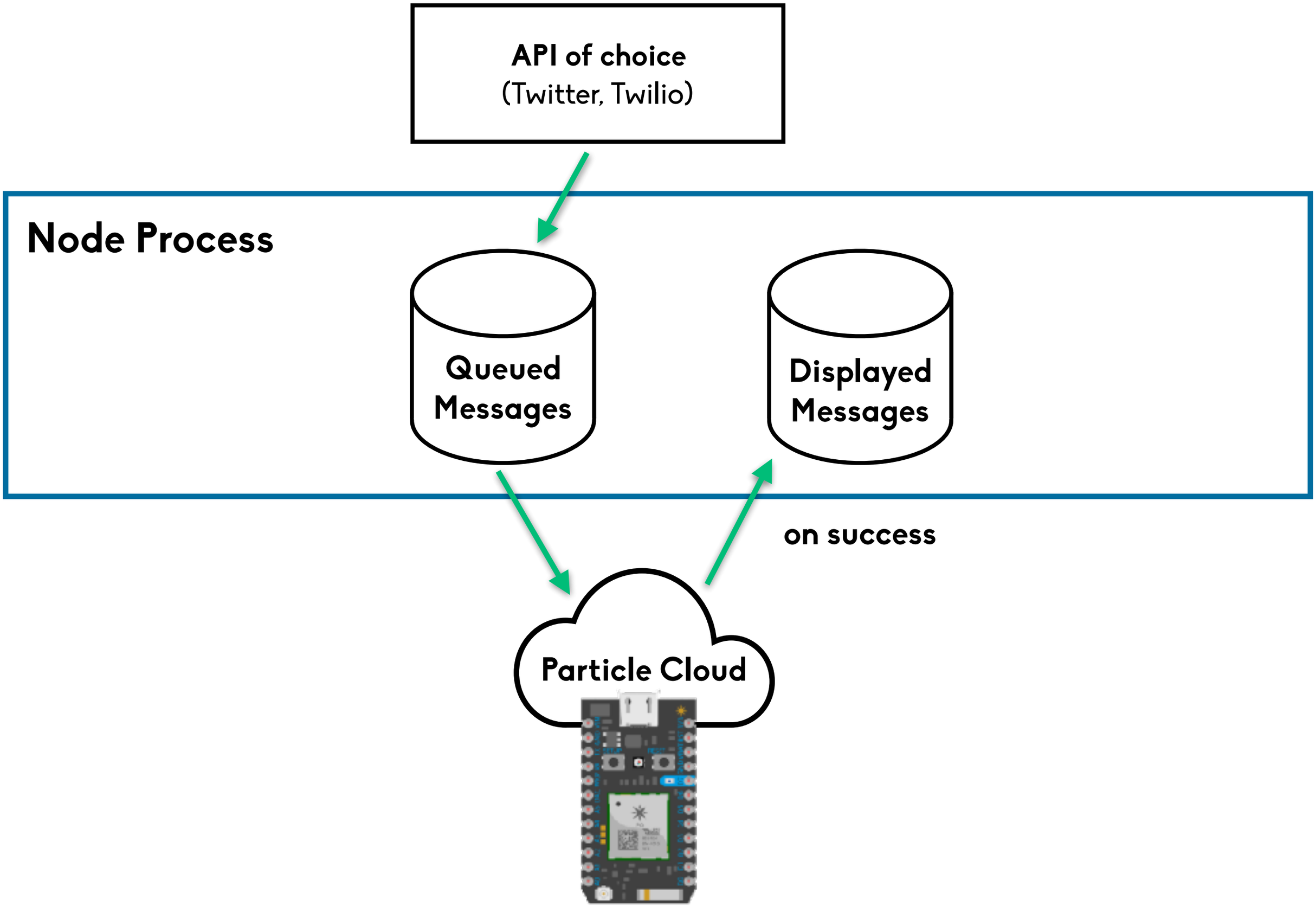
Queued Messages

Displayed Messages

POST with device id, access token, and message

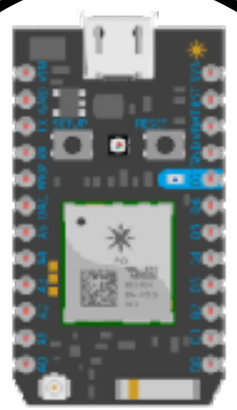
Particle Cloud




API of choice
(Twitter, Twilio)
Node Process
Queued Messages
Displayed Messages
on success
Particle Cloud

IOT Method #2

Webhook Publish & Subscription



Particle Cloud

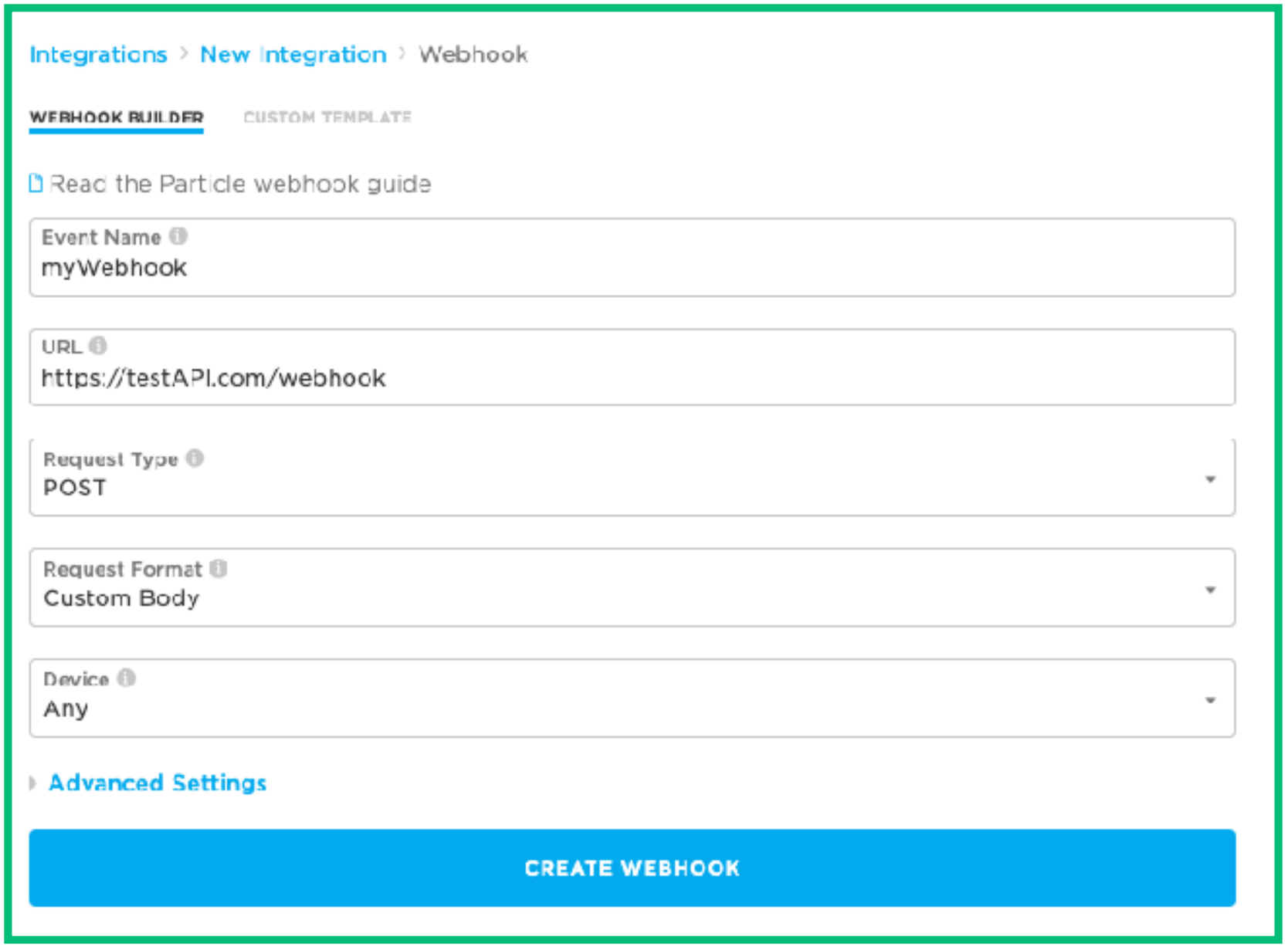
Webhook integration

Webhook Server
or Lambda

Subscription to response

Webhook Setup

console.particle.io



Hardware Code

build.particle.io

```
void setup () {
    // Subscribe to the integration response event
    Particle.subscribe("hook-response/myWebhook",
        changeHandler, MY_DEVICES);
}

uint32_t publishTimer = millis();

void loop () {
    // if millis() or timer wraps around, we'll just reset it
    if (publishTimer > millis()) publishTimer = millis();

    if ((millis() - publishTimer > 60000)) {
        publishTimer = millis(); // reset the timer
        Particle.publish("myWebhook", 'data', PRIVATE);
    }
}

void changeHandler(const char *event, const char *data) {
    // handle webhook response
}
```

Webhook integration

for example, sending coordinates from a gps to a lambda to process

Hardware Code

build.particle.io

```
1  void setup () {
2      // Subscribe to the integration response event
3      Particle.subscribe("hook-response/myWebhook",
4          changeHandler, MY_DEVICES);
5  }
6
7  uint32_t publishTimer = millis();
8
9  void loop () {
10     // if millis() or timer wraps around, we'll just reset it
11     if (publishTimer > millis()) publishTimer = millis();
12
13     if ((millis() - publishTimer > 60000)) {
14         publishTimer = millis(); // reset the timer
15         Particle.publish("myWebhook", 'data', PRIVATE);
16     }
17 }
18
19 void changeHandler(const char *event, const char *data) {
20     // handle webhook response
21 }
```

Subscription to response

for example, returning a “score” for a location and displaying something according to that score

Javascript & Hardware

The Good:

Fully extendable

More easily understood by general hardware community

Scalable

The Bad:

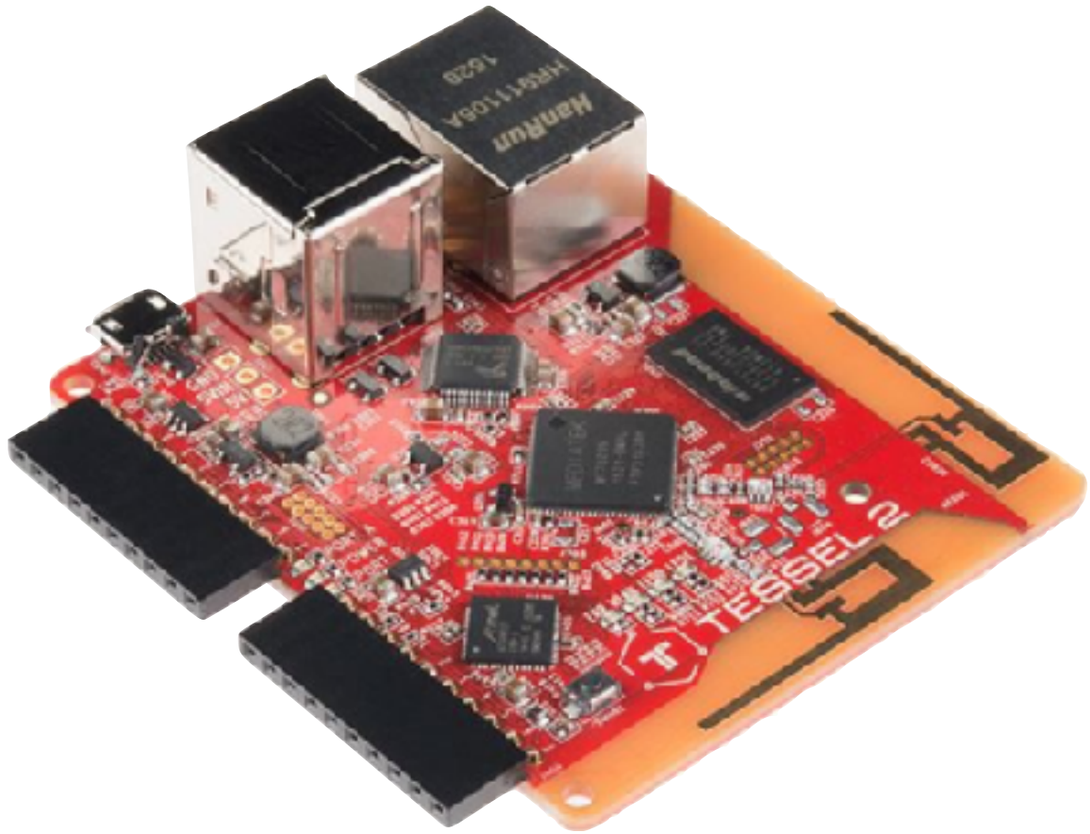
Locked into the Particle Platform

Requires C programming

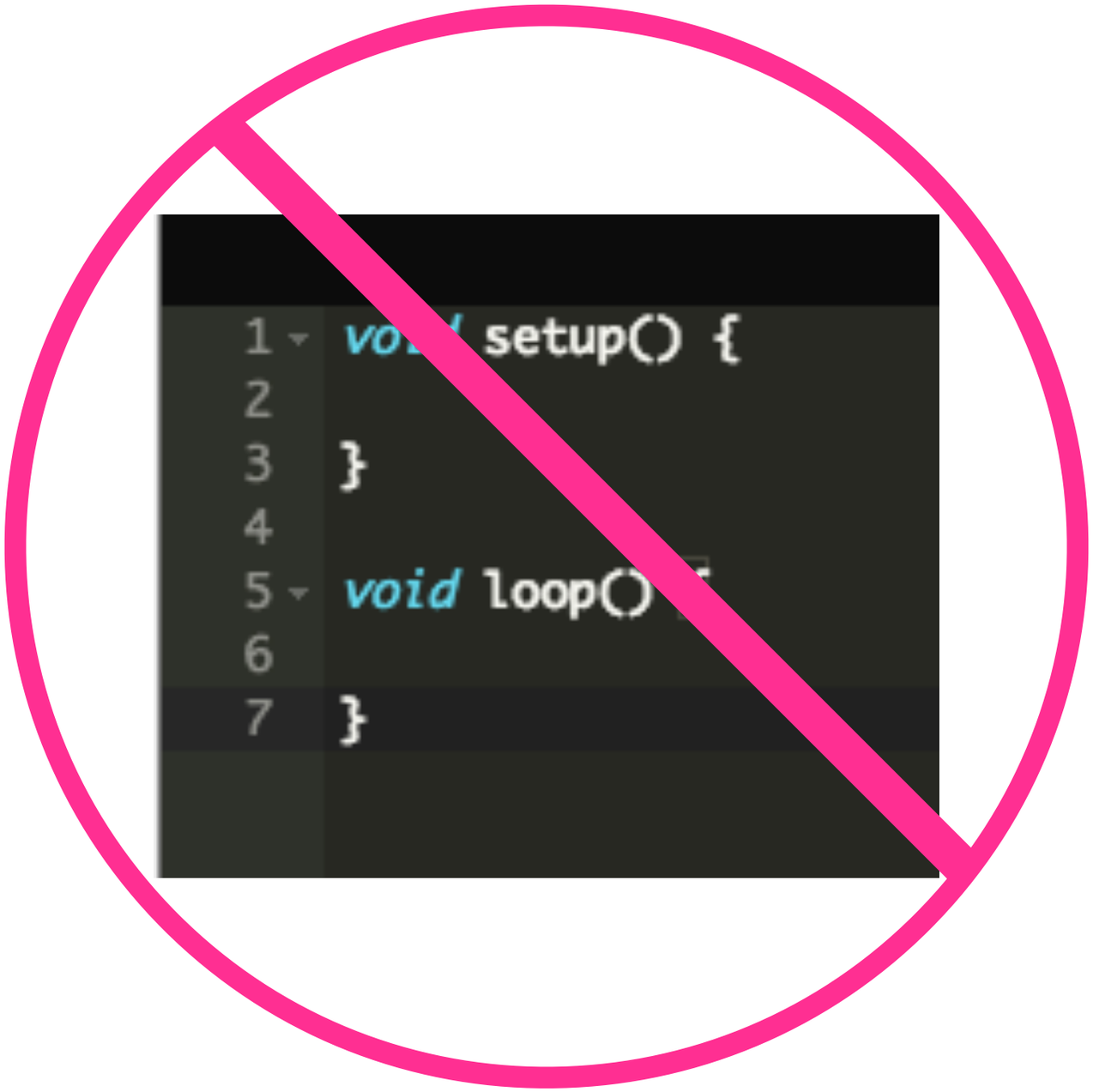
Other Options

- **Firmata** / Nodebots
  - Can work on any Arduino
  - Firmata (protocol to talk to microcontroller) uploaded to Arduino board of choice
  - Javascript library that abstracts the Firmata protocol allows you to program all in Javascript
  - Example libraries: **Johnny-Five, CylonJS**

Other Options



- **Tessel2**
  - Specific board
  - Works similarly to Firmata, but all packaged on one microcontroller
  - A part of a board called the MediaTek (system on a chip) packages up the commands and routes them


1 void setup() {
2
3 }
4
5 void loop() {
6
7 }

```
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  // LED_BUILTIN is D13 on the Uno
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```

```
var five = require("johnny-five");
var board = new five.Board();

board.on("ready", function() {
  var led = new five.Led(13);
  led.blink(1000);
});
```

```
strip.on("ready", function() {
    dynamicRainbow(fps);
});

function dynamicRainbow( delay ){
    var showColor;
    var cwi = 0; // colour wheel index (current position on colour wheel)
    var foo = setInterval(function(){
        if (++cwi > 255) {
            cwi = 0;
        }

        for(var i = 0; i < strip.length; i++) {
            showColor = colorWheel( ( cwi+i ) & 255 );
            strip.pixel( i ).color( showColor );
        }
        strip.show();
    }, 1000/delay);
}
```

loop code, without loop()

The Good:

All Javascript

Allows you to stick to one language

Easier to learn and teach

The Bad:

All Javascript

Library dependent

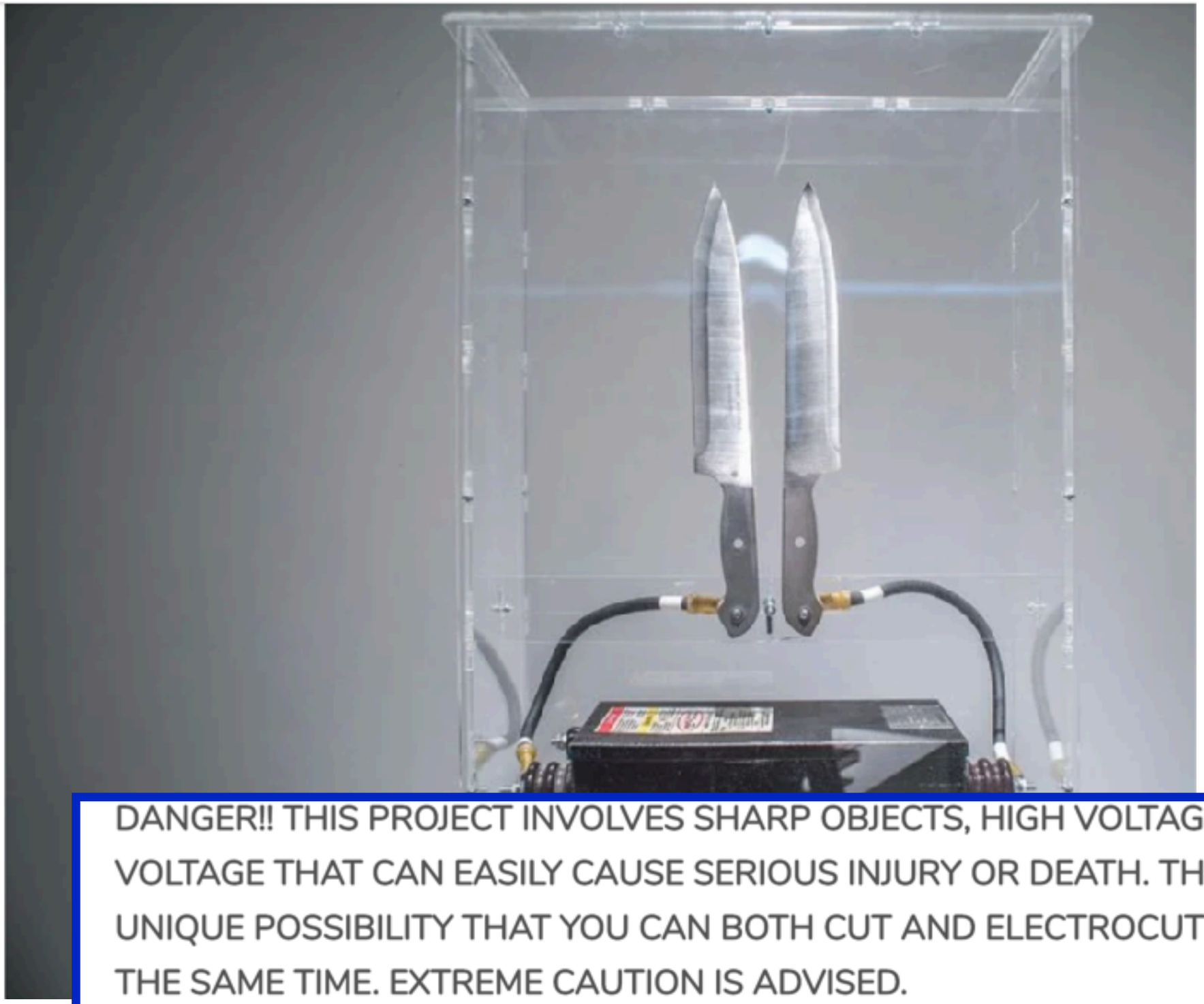
Less ability/harder to customize if needed

Maybe harder to find help with a library vs a language

Tips for Beginners

Start Simple and Build Up!

How to Build a Jacob's Ladder With Knives by neilmendoza Follow



DANGER!! THIS PROJECT INVOLVES SHARP OBJECTS, HIGH VOLTAGE AND MAINS VOLTAGE THAT CAN EASILY CAUSE SERIOUS INJURY OR DEATH. THERE IS THE UNIQUE POSSIBILITY THAT YOU CAN BOTH CUT AND ELECTROCUTE YOURSELF AT THE SAME TIME. EXTREME CAUTION IS ADVISED.

You don’t have to start with wireless!

Get it working on an **Arduino Uno** first!

No over the air flashing code

Most of the time, you can copy/paste code over to the Particle when you’re ready!

Find friends!

https://www.meetup.com/bitraf/

https://embedded.fm/

Other Sensors/Displays

Google ‘Arduino ‹what you’re trying to sense›’

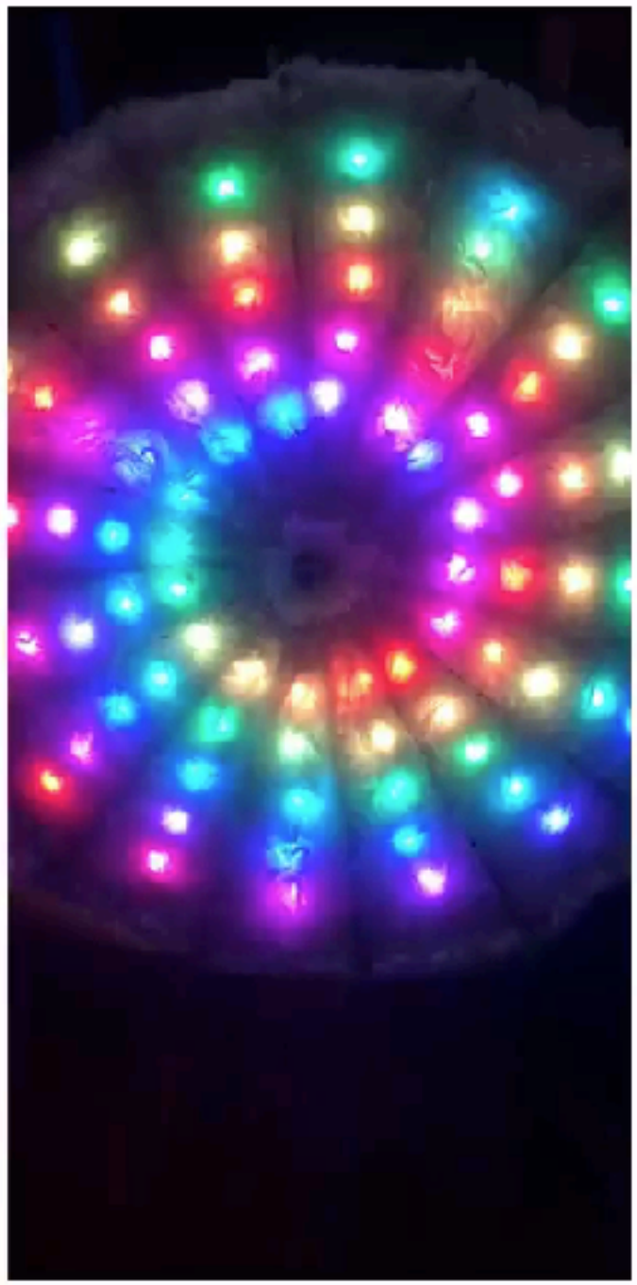
Be sure the **library is available** for Particle

Check the forums for more help

Other Libraries

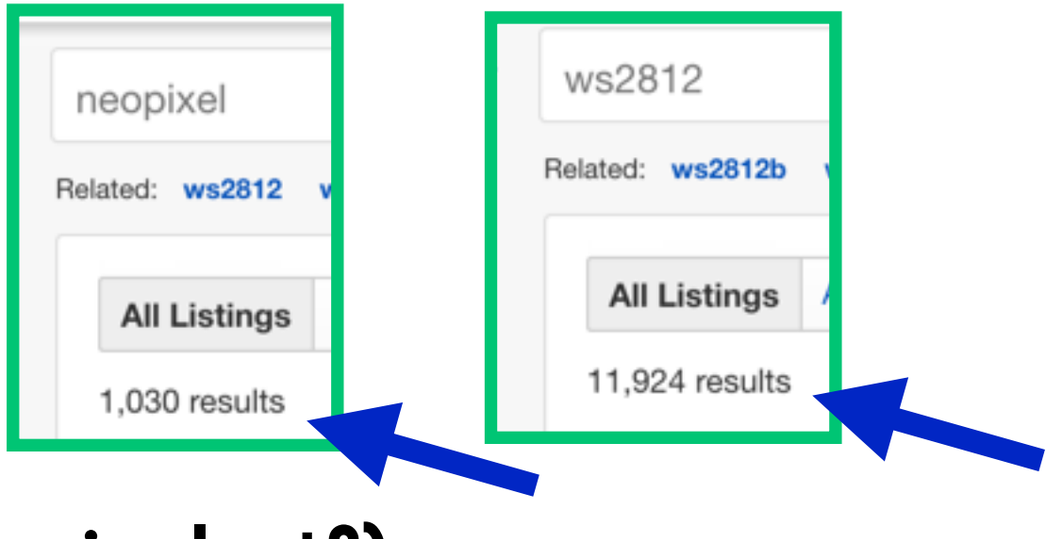
Normal Rainbow

FastLED's
color blending



Buying Components

- **Find the chip number of what you want**



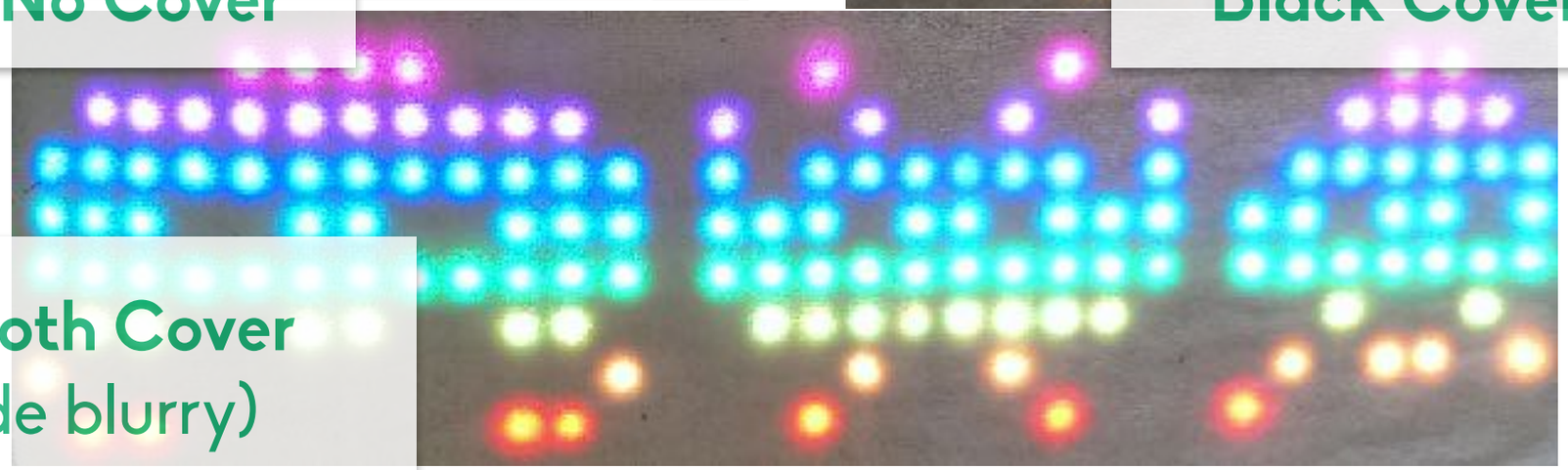
- **Ebay (Norway equivalent?)**
  - Shipping from China is slow
  - Popular items may be in closer inventories

Wearable Tips

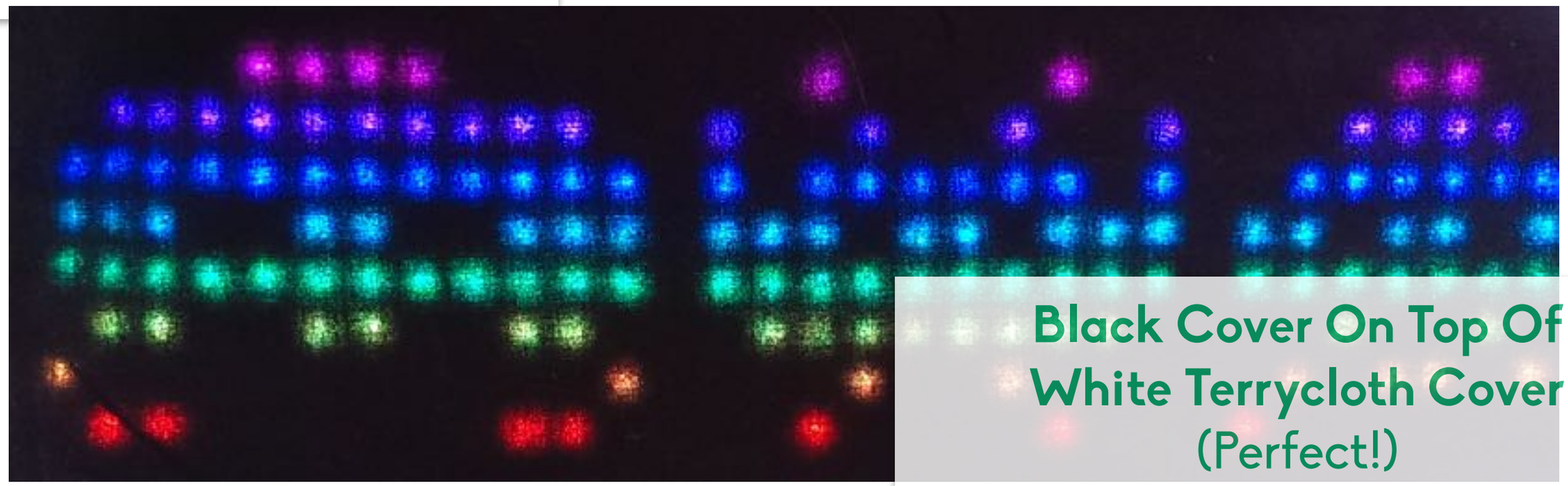
- Again, **start simple, build up**
- Think about **batteries** early on
  - Anker Powercore 5000
- How things will be anchored to the fabric
- How things will interact with the body (movements, sitting, etc)

No Cover

Black Cover



White Terrycloth Cover
(Light is made blurry)



Black Cover On Top Of
White Terrycloth Cover
(Perfect!)

Brandon Satrom
Particle

Thursday, 16:20, Room 1

ML and the IoT: Living on the Edge
Doing machine learning on the microcontroller or computer local to the sensors.

Hans Elias B. Josephsen

Sebastian Roll
Webstep

Friday, 10:20, Room 4

From circuit board design to finished product: the hobbyist's guide to hardware manufacturing
Getting a hardware project designed and manufactured.

Takk så mye!!

https://github.com/gelicia/ndcOslo2019

Kristina Durivage - @gelicia