Urban Farming IoT Workshop

Bring IoT where no one has been before

and

David Middlecamp
@dmiddlecamp

David Washington
@dwcares

four maker stories

chickens

sweaty bodies

tennis balls

<your thing>

Meet Pete and Kate!

Like you they make stuff

some things they made

some other things they made

“Nice farm! Can I throw some sensors in there?”

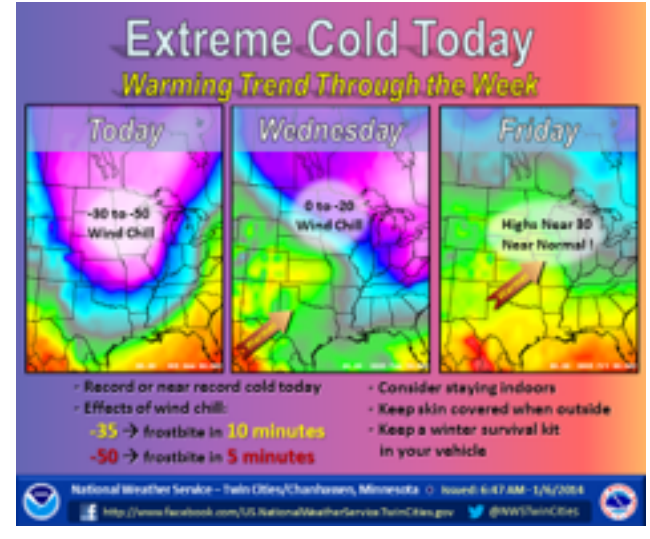
–Me

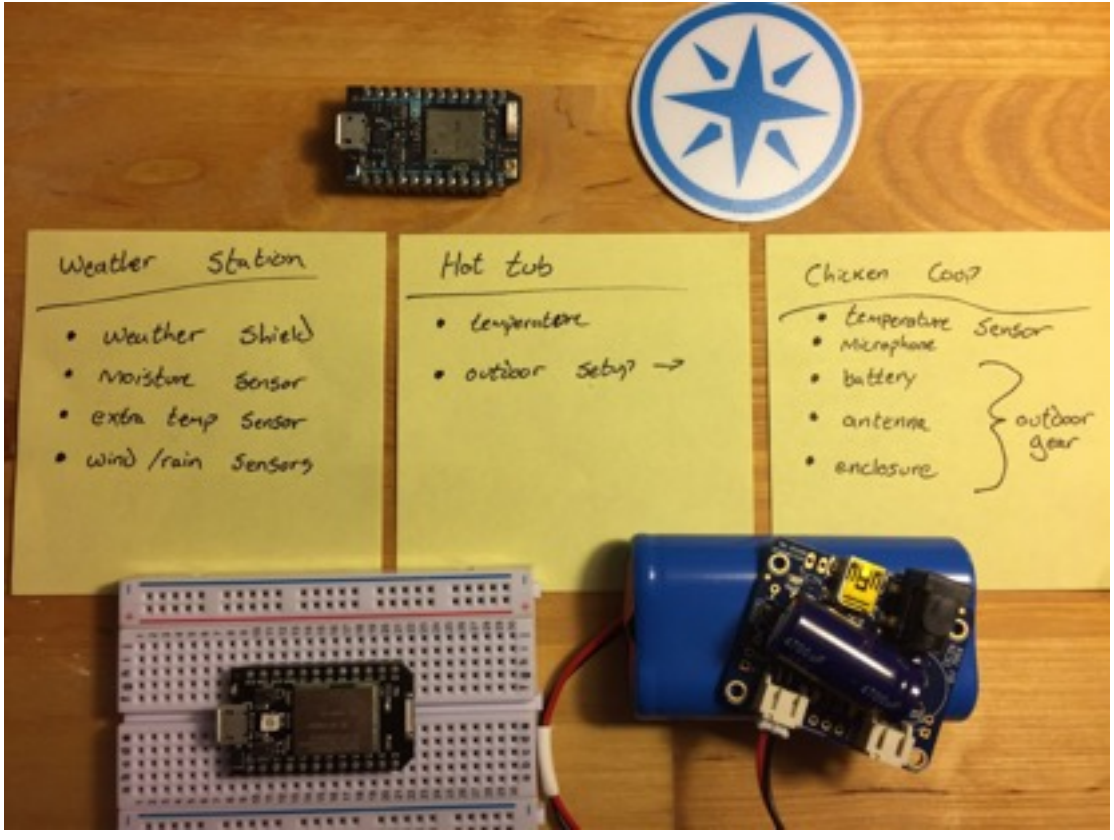
“What to do”

when you just committed to a huge project

lets scope this out

- **What is most important?**
    - help preserve and enrich life on the farm!
    - lets watch the hot tub, the chickens, and the general weather
- **low impact**
    - self contained (minimal farm impact / maintenance)
    - try to survive the winter
- **easy to build**
    - should be something anyone can build
    - open source!
- **Our farmers, Pete and Kate own their data!**
    - it's a farm, so I want to store many seasons of data





Lets pick our tools

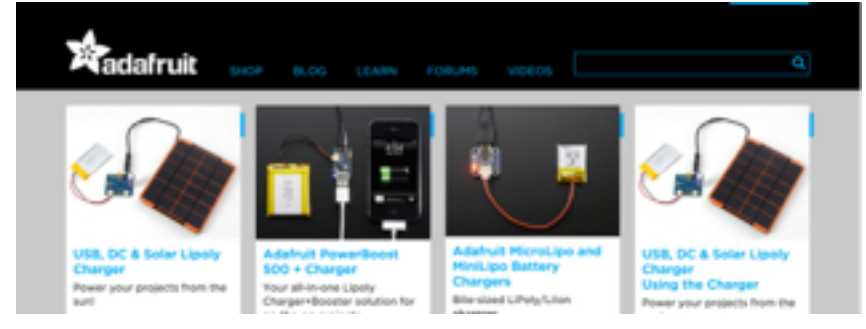
some things you might need when building weather resilient, self-contained, solar powered, internet connected farm sensors

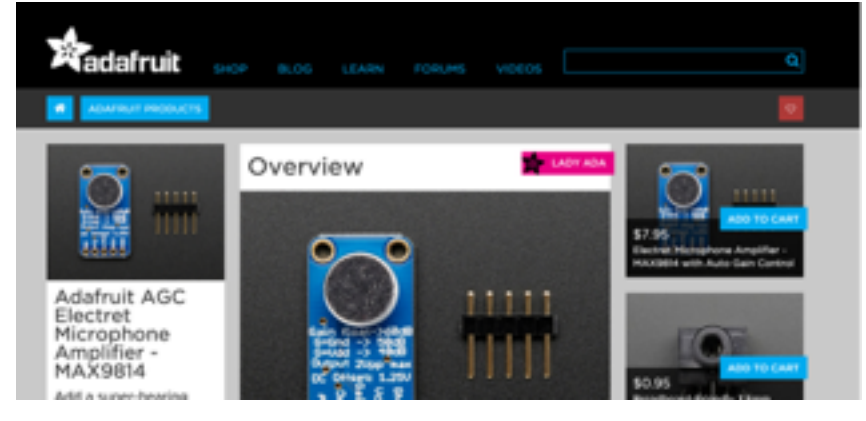
Weather shield and sensors from

- Easy to use libraries and examples!
- Gives us temperature, humidity, wind speed, wind direction, rainfall, plus breakouts for adding more!

Solar panels, batteries, battery chargers, and more from

- Awesome tutorials!
- Lets our devices be self contained and weather resistant!
- Lets ballpark our power usage around 100mAh
- So 3w-6w panels should be fine for now,
- batteries 2500mAh and up since we’re in MN and have low light





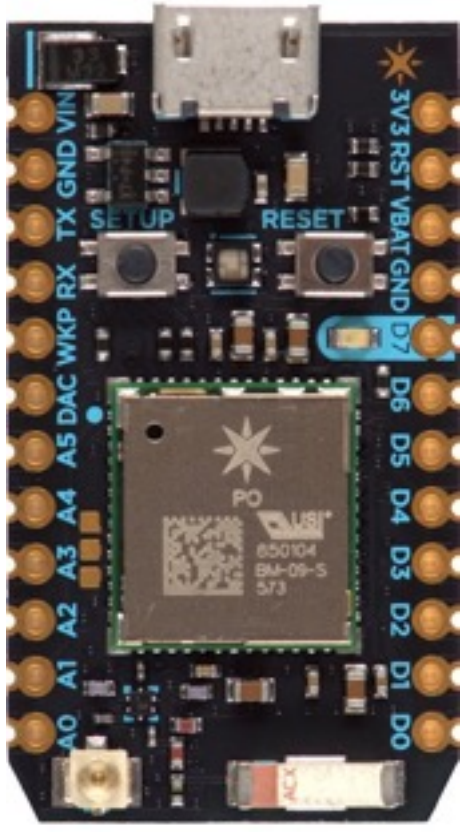
Mason Jars!

(for maximum pinterest appeal)
(also they are waterproof)

- Low cost!
- Reusable enclosure!
- room for activities!
- salads!

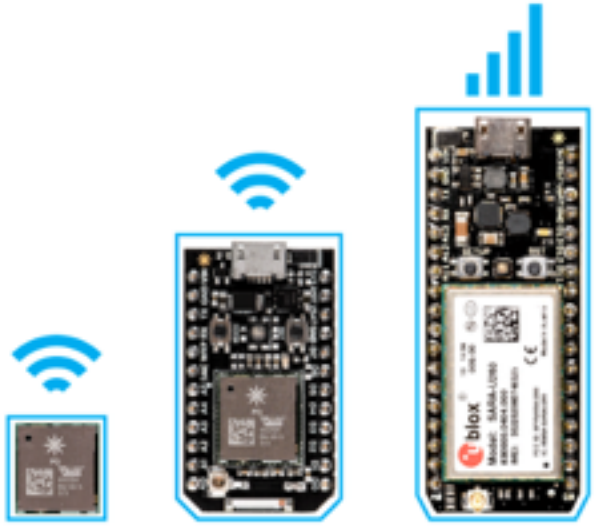
Photons!

- glues everything together!
- awesome community!
- tons of example projects
- open source!
- low cost ($19) !
- reusable!
- https://particle.io
- There's a book by Simon Monk!
- *fancy edges for easy soldering!*
- *bluetooth co-existence pins!*
- *at least 2 leds and 2 buttons each!*



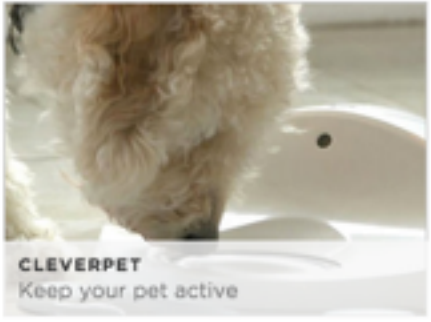
*not actual size

Built with the Particle Platform



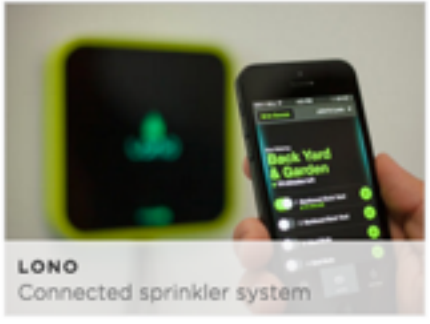
GROVE LABS
A living ecosystem in your home

FISHBIT
Your aquarium made simple

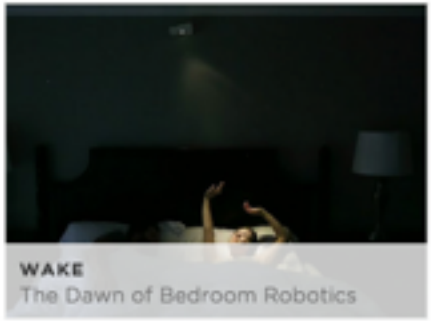


CLEVERPET
Keep your pet active

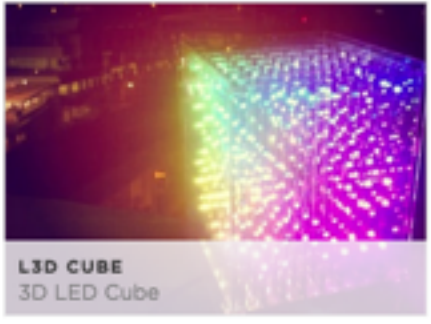
WATER HERO
Automated leak detection



LONO
Connected sprinkler system



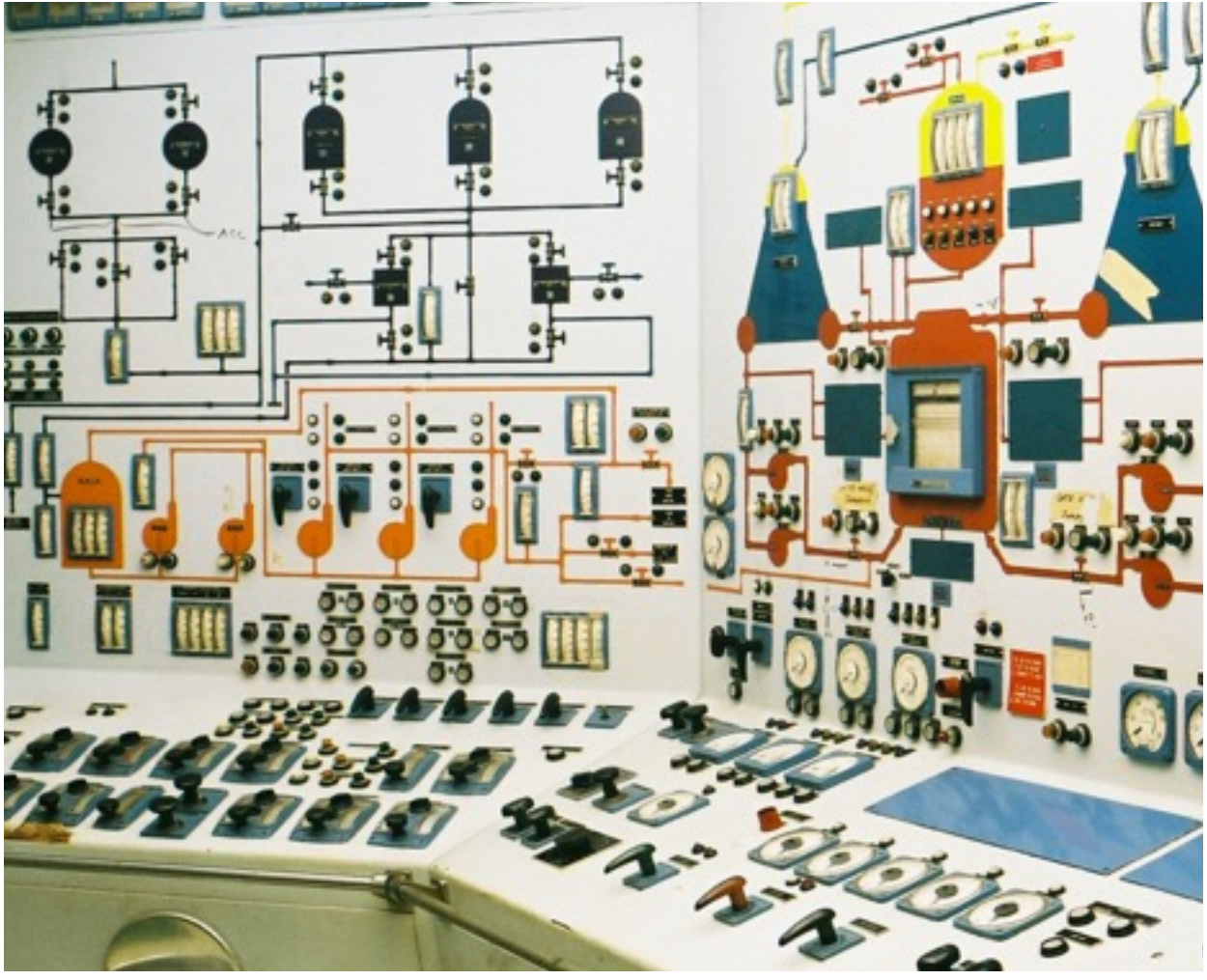
WAKE
The Dawn of Bedroom Robotics



L3D CUBE
3D LED Cube

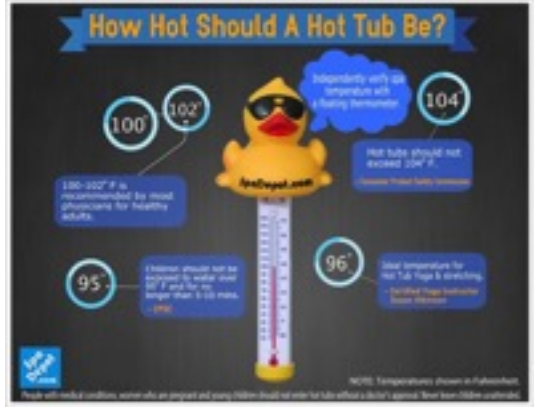
ARIO
Lighting your way to better health

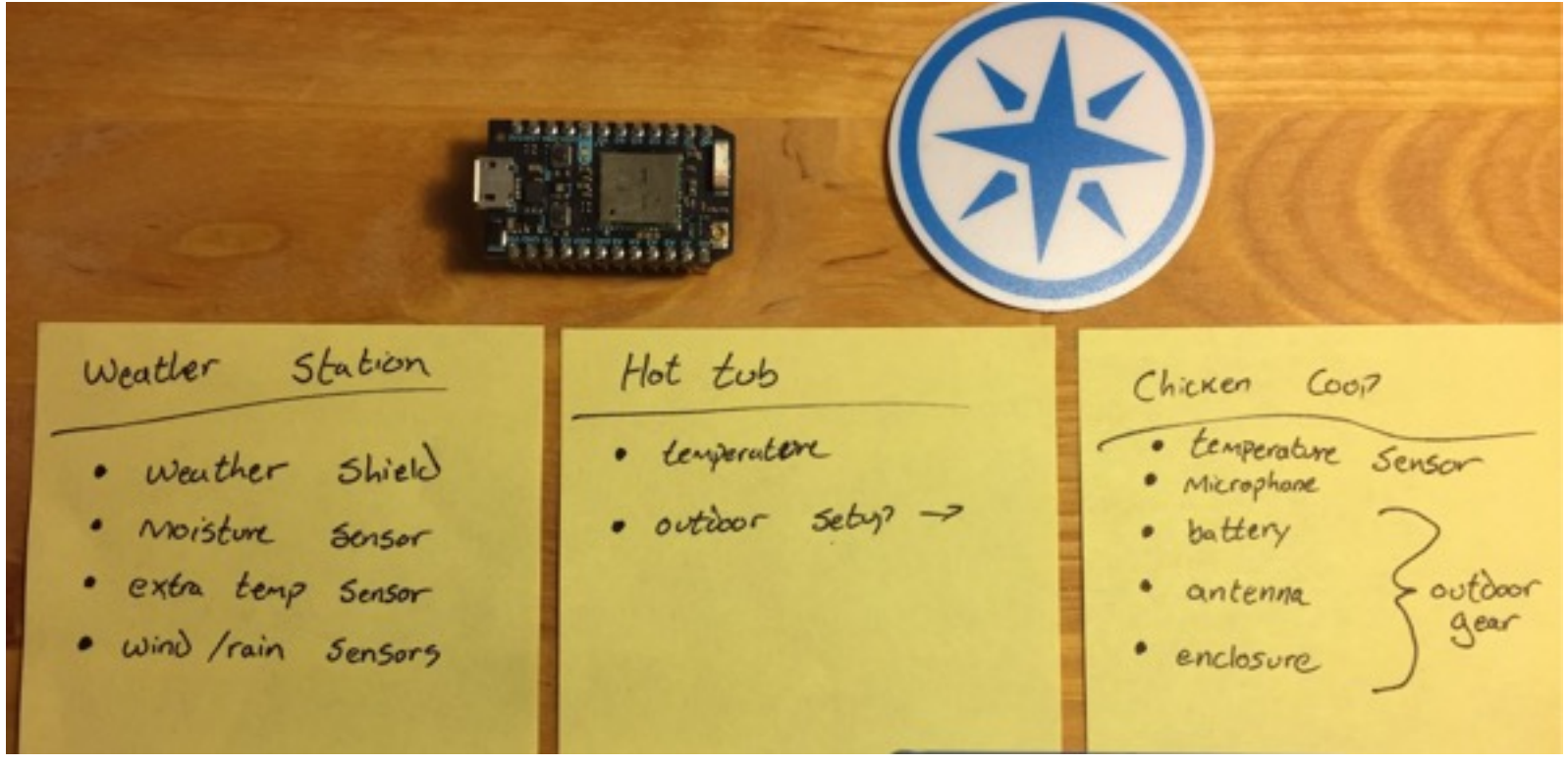
Bonus features!



Temperature and Sound!

- sometimes the most simple sensors are the most interesting
- temperature!
    - we could show when it's safe to use the hot tub!
    - could try to detect when people are sitting in the tub, or when a new log needs to be added
    - we could try to detect when the soil is wet (when it loses temperature faster than normal)
    - could try to detect when the hose will freeze
    - detect if the coop door is stuck open on a cold day
- microphones!
    - sound intensity (decibels), and FFTs!
    - might show if a predator is nearby, if the chickens are active, happy, etc
    - try to understand when they're more / less active

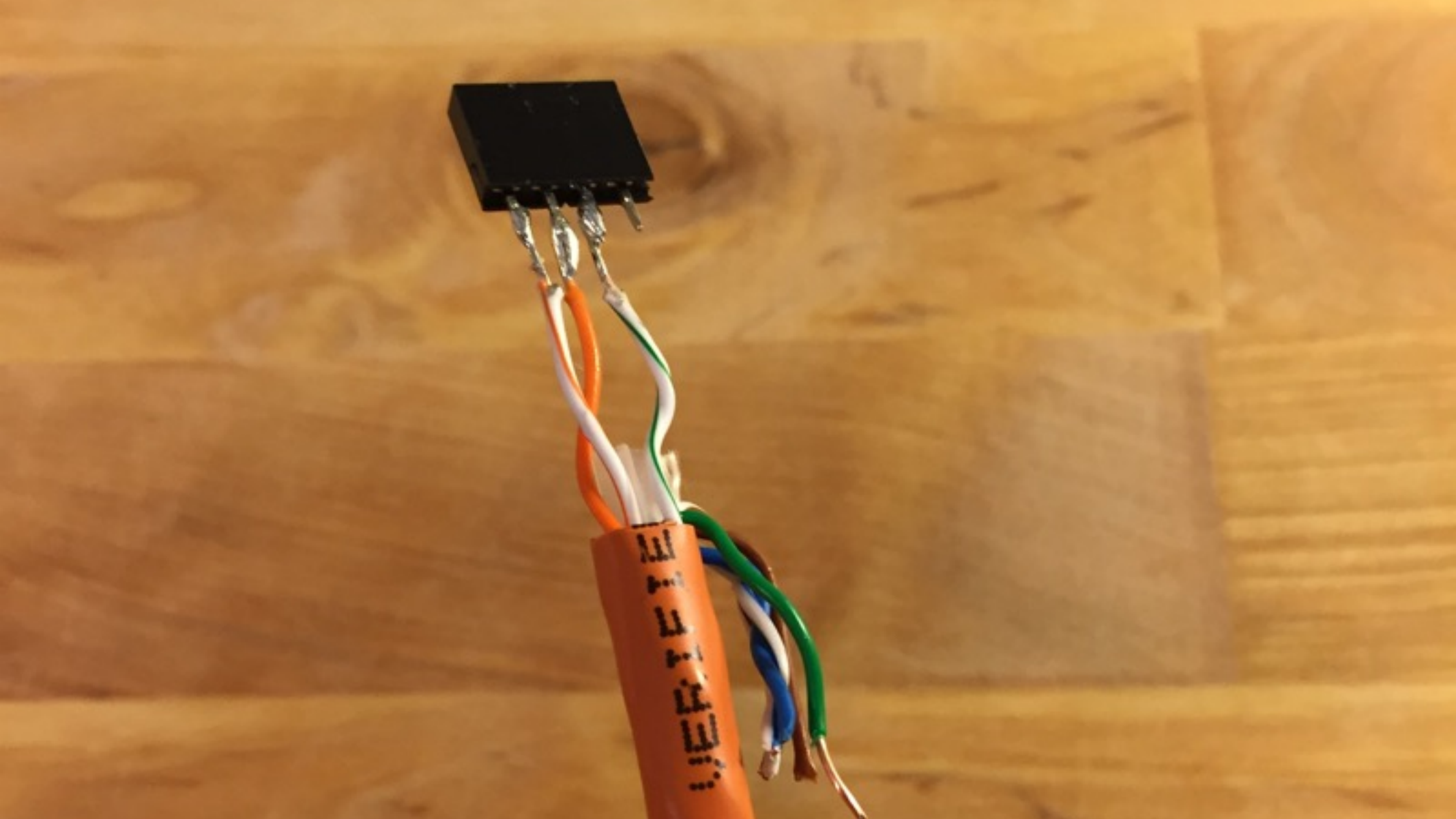


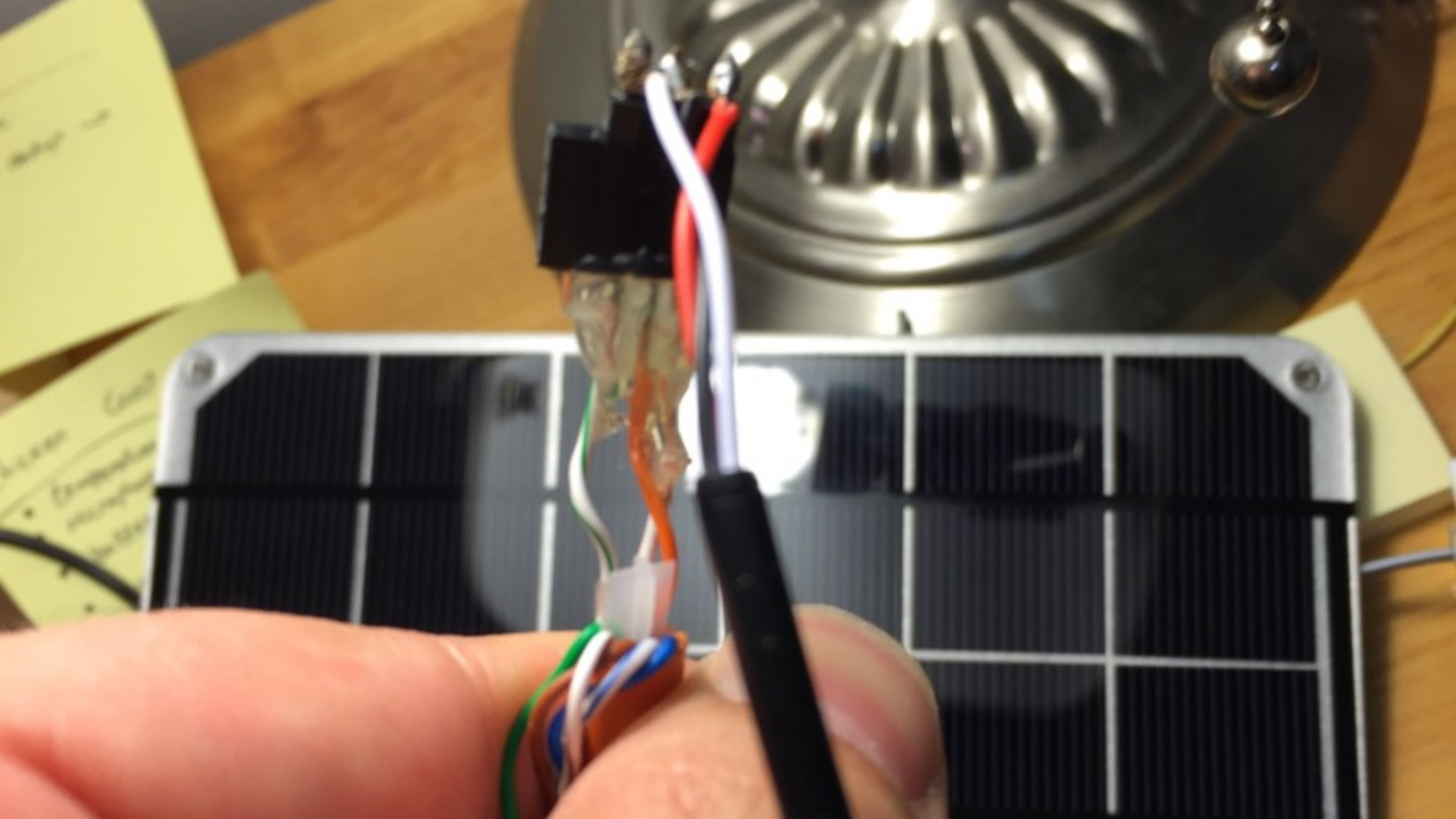


Lets put it together!

Hot tub
• temperature
• outdoor sensor? →

Hot Tub Sensor Pack!



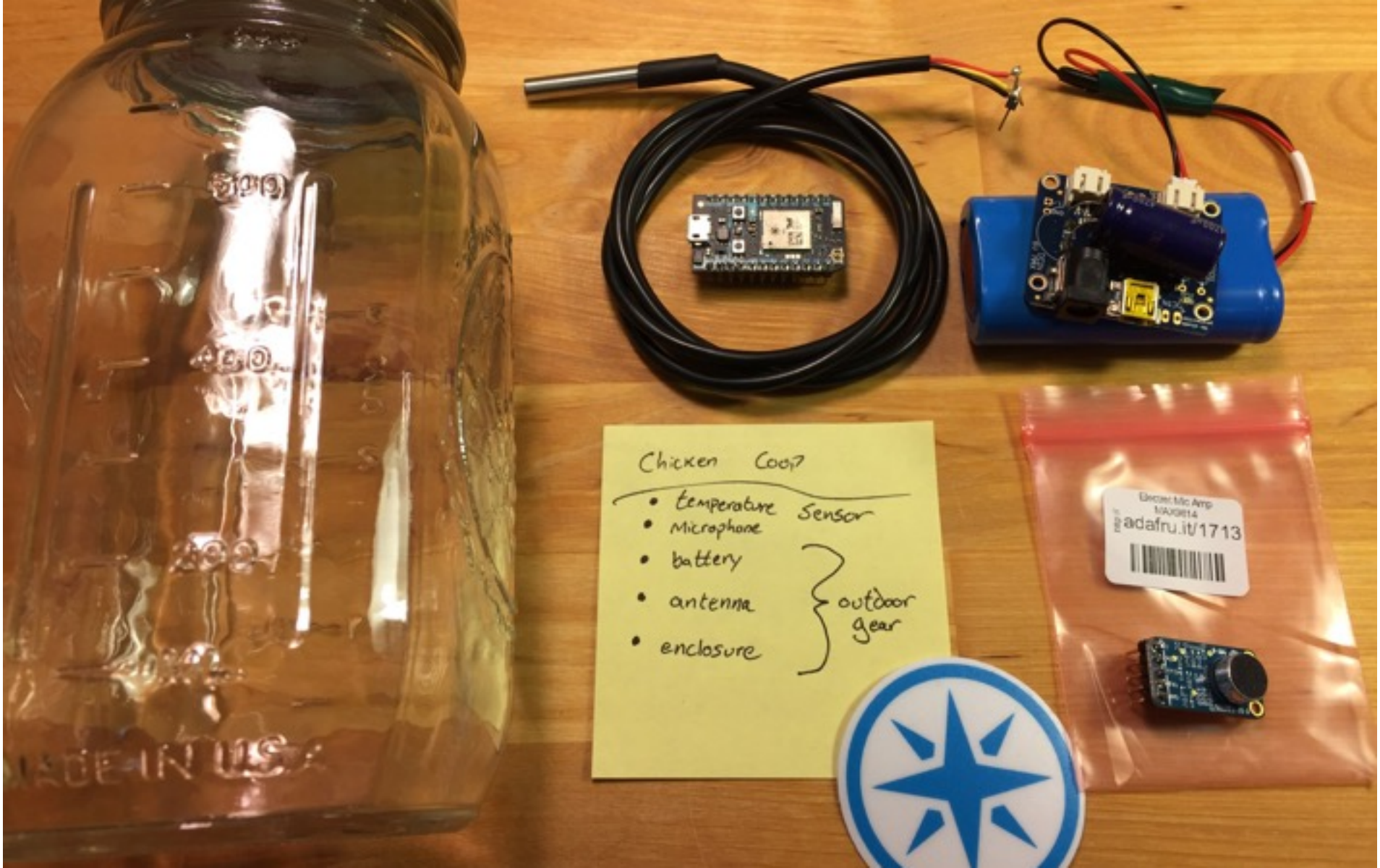


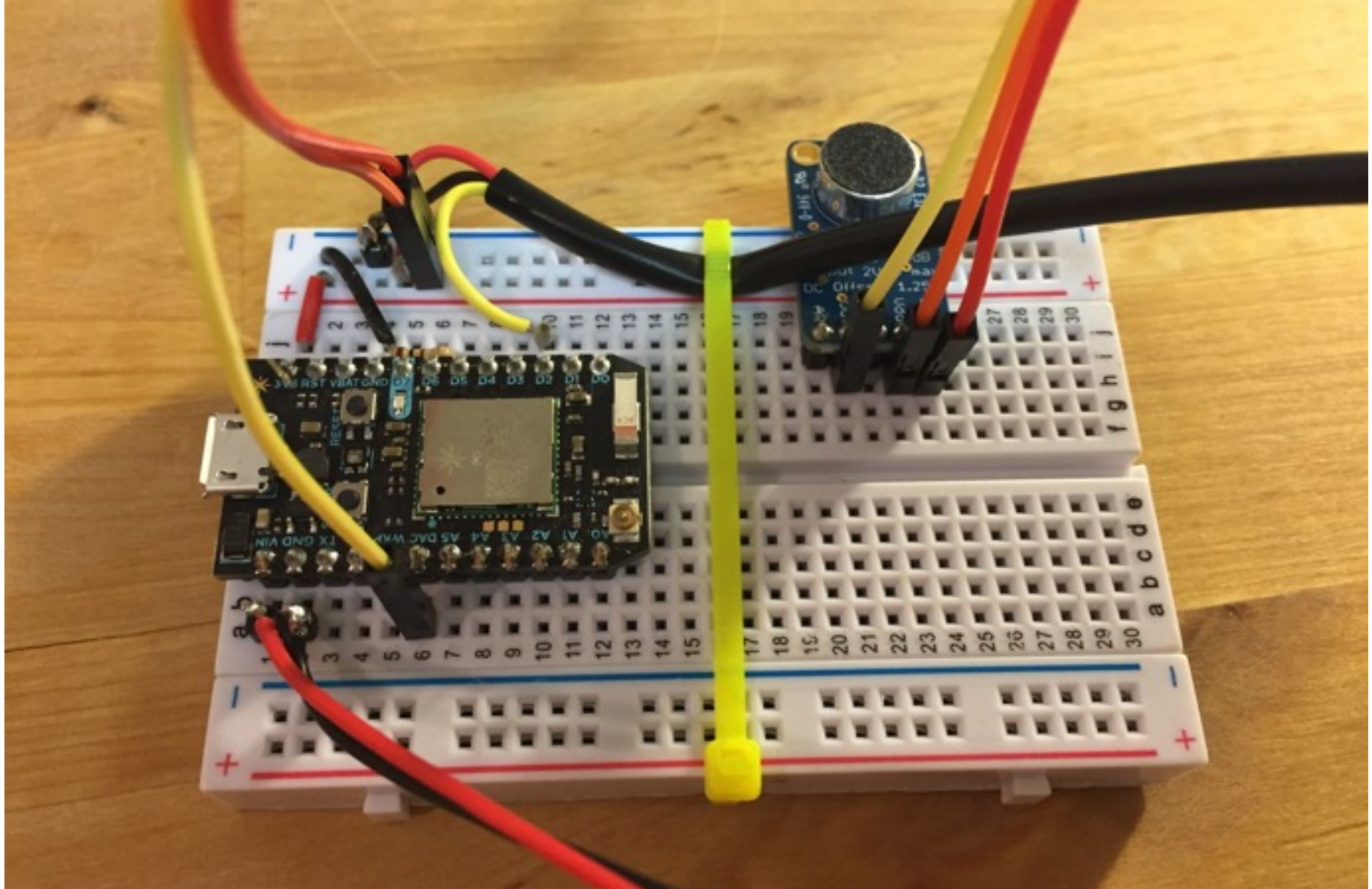
18v
BLACK & DECKER
FIRE STORM
crafted for quality–
sealed for freshness
Made in USA
Ball
BLACK & DECKER. 18v

BLACK & DECKER
FIRE STORM
18v
crafted for quality–
sealed for freshness
Made in USA
Ball

470µF
10V
DC IN
6V MAX

Chicken Coop Sensor Pack!


Chicken Coop
temperature sensor
Microphone
battery
antenna
enclosure
outdoor gear
adafru.it/1713



Weather Station!

Weather Station
• Weather Shield
• Moisture Sensor
• extra temp Sensor
• wind /rain Sensors

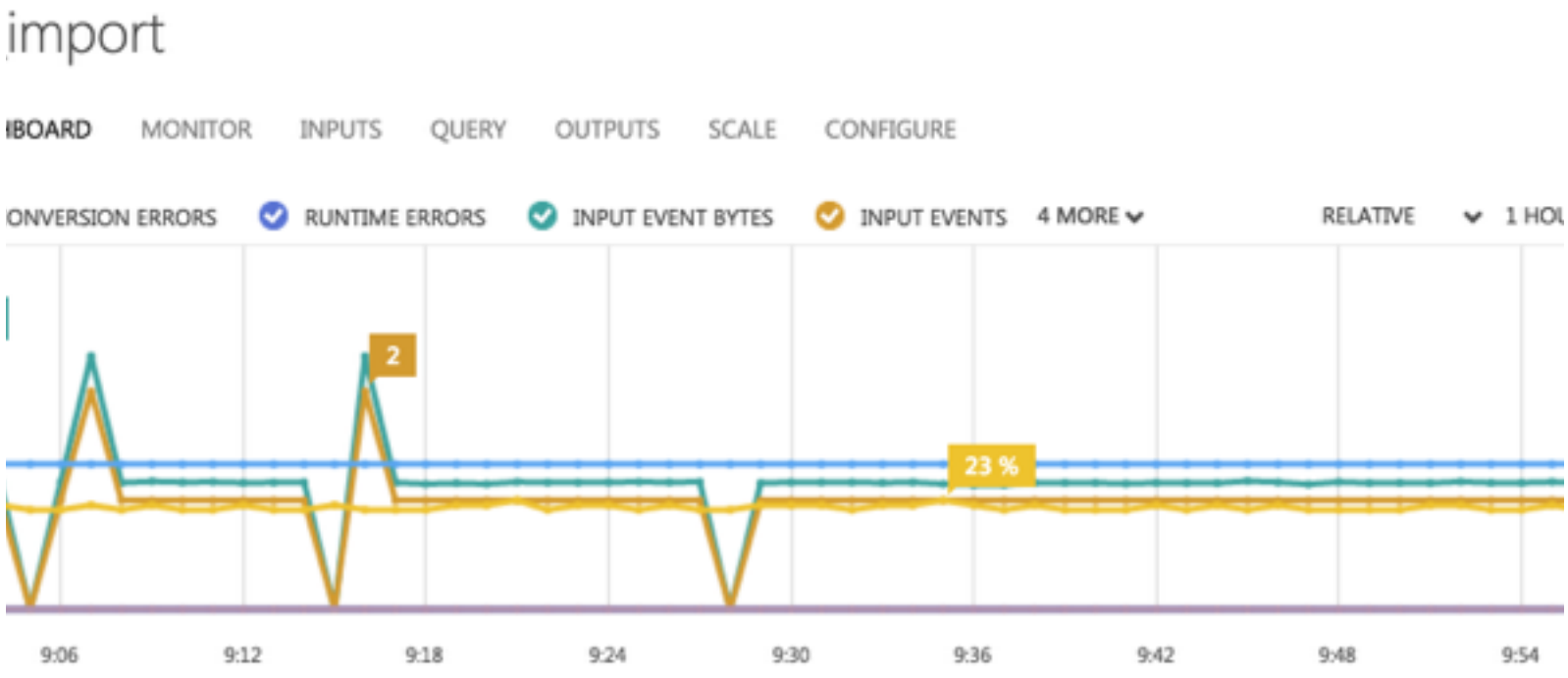
Deploying your devices!

INTERNET
WI-FI
SPARK CORE
ANKER
ANKER
ANKER

Charging
Port
USB/232

THIS INTERNET.
WELL, MAYBE NOT THE INTERNET YOU'RE USED TO.
THIS LITTLE GUY COMMUNICATES TO THE INTERNET
AND WHEN HE DOES, HE BRINGS ALONG WHATEVER HE'S CONNECTED TO.
POWER OUTLETS
BUTTONS
OVER
CAMERAS
CONTROL CARS
WI-FI
REMOTE
AND WHEN THE INTERNET SPILLS OVER INTO THE REAL WORLD, EXCITING THINGS HAPPEN.
LIKE TOYS THAT LEARN
OR A WI-FI PB&J
WITH THE SIMPLICITY OF AN ARDUINO, AND THE POWER OF AN ARM CHIP.
THIS IS THE
SPARK CORE.

HOW TO USE GRAPHPRO SUPERGRA



Time for the Data!

Give the devices something to do!

- Make some firmware! (easiest to start from examples!)

```
// Define the pins we will use
int ow = D2;    // put the onewire bus on D0

OneWire ds(ow);  // a 1 - 4.7K resistor to 3.3v is necessary

void setup(void) {
  Serial.begin(57600);  // local hardware test only

  Spark.publish("farm_coop", "online_1.2");
}
```

- You can use mine!
  https://github.com/dmiddlecamp/petesfarm

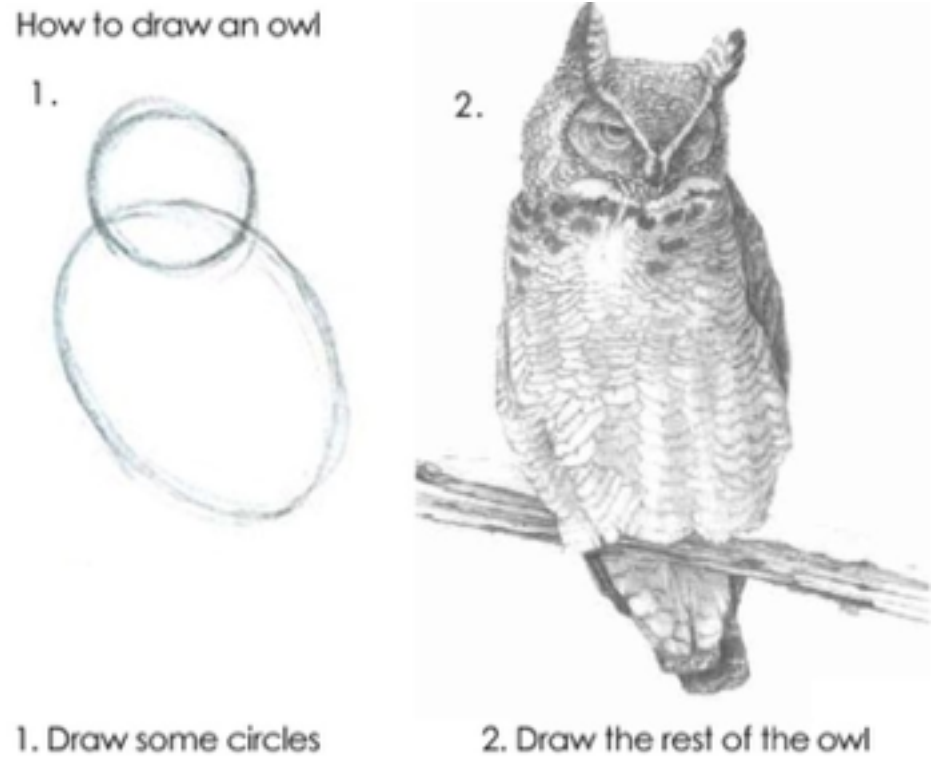
Build your webhook!

- Make some data!

```
Spark.publish("some_data", some_variable);
```

- Send it somewhere!

```
particle webhook POST some_data https://some_website.farm
```



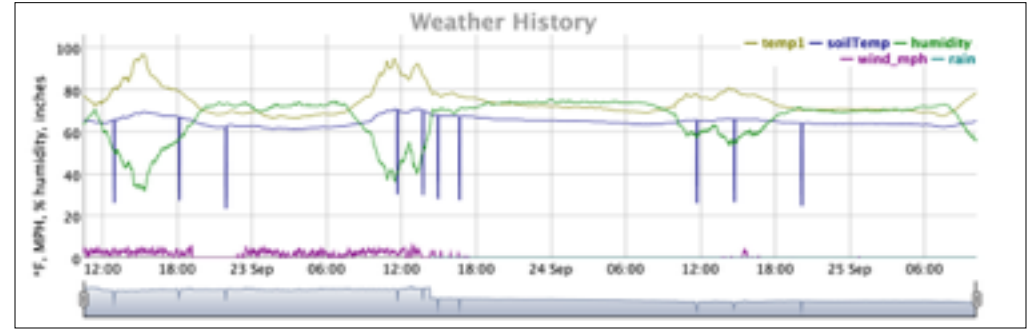
Using the Data!

What tools should we use?

- Lets use Node.js for programming!
- Dygraphs for charting (since it handles large datasets well)
- Express.js for the Web server
- SQL Server from Azure because that connects easily to Azure service bus
- You can use my code!
  https://github.com/dmiddlecamp/petesfarm

What can we build in a day?

- minimum viable product, get your marshmallow!
- we'll learn more when we see them using it
- basic heads up info, something you could use while farming

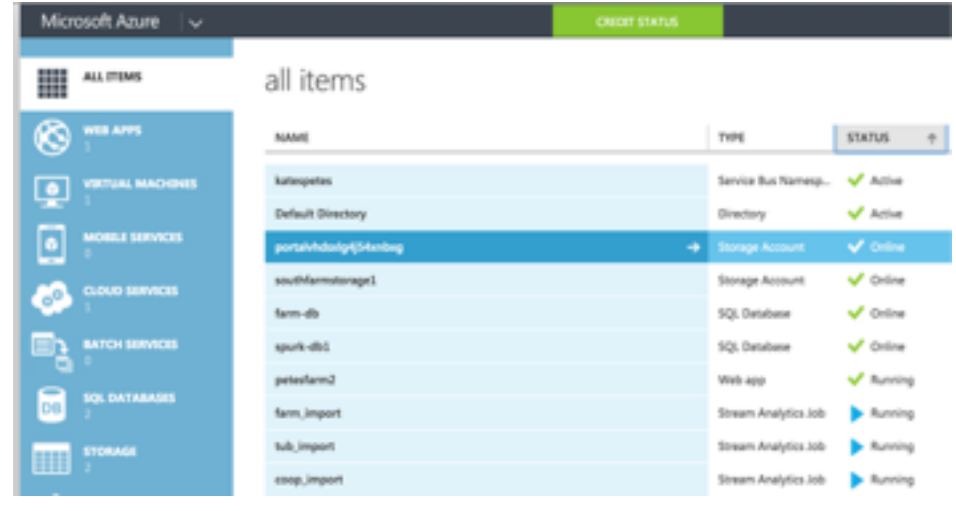



```
router.get('/', function(req, res, next) {
    res.send({
        routes: [
            { url: "coop.json", desc: "chicken
            { url: "tub.json", desc: "hot tub
            { url: "weather.json", desc: "weat
            { url: "latest.json", desc: "most
        ]
    });
});
```

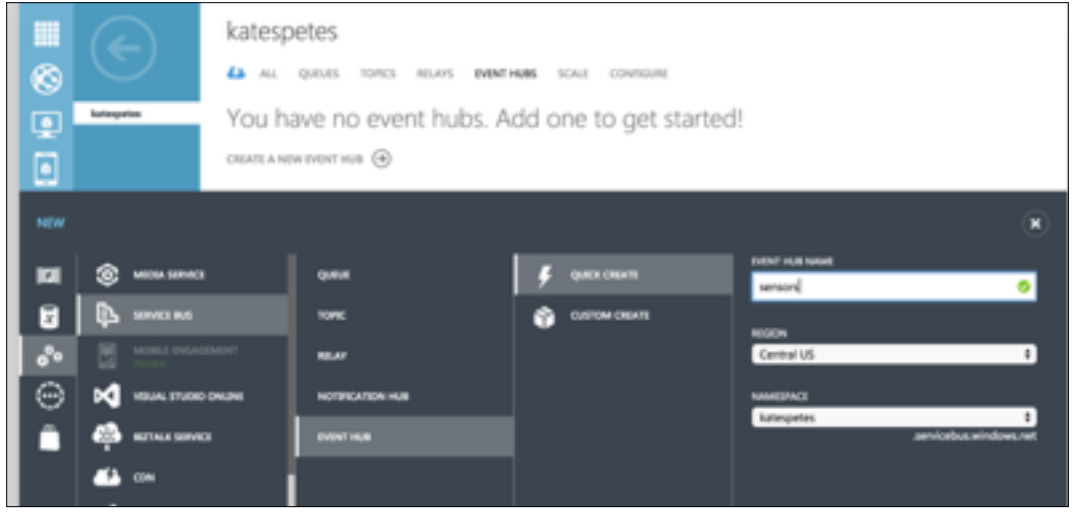
Azure + Particle!

(databases, and web app hosting for long-term data storage and machine learning!)

- managed apps / databases
- some free tiers!
- easily connects to Particle
- long term data storage with full ownership!
- Particle + Azure scale well together



Azure service bus / event hubs



```
10.) Hook ID 56005dcf78c13d5648e2bcb5 is watching for "farm"
     and sending to: https://katespetes.servicebus.windows.net/sensors/messages
     created at 2015-09-21T19:43:11.968Z
```

Connectivity

IoT Hub

Event Hub

Storage

Azure SQL

Storage blobs

DocumentDB

Analytics

Azure HDInsight

Azure Machine Learning

Stream Analytics

Take Action

Azure Active Directory

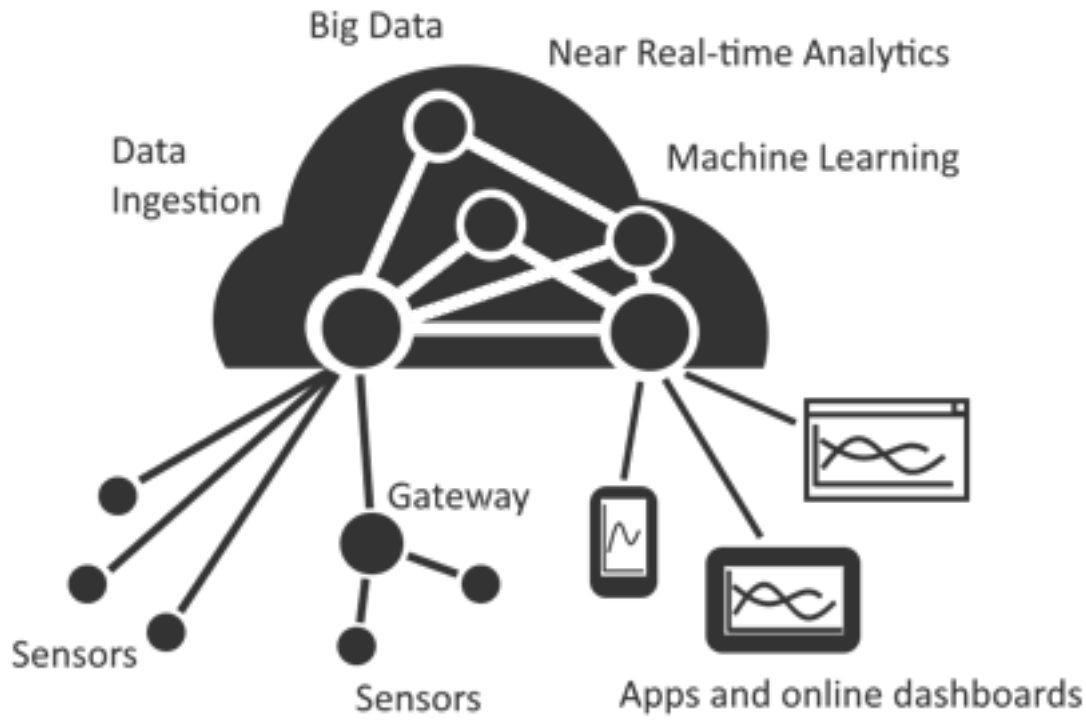
Web Jobs

Azure Function

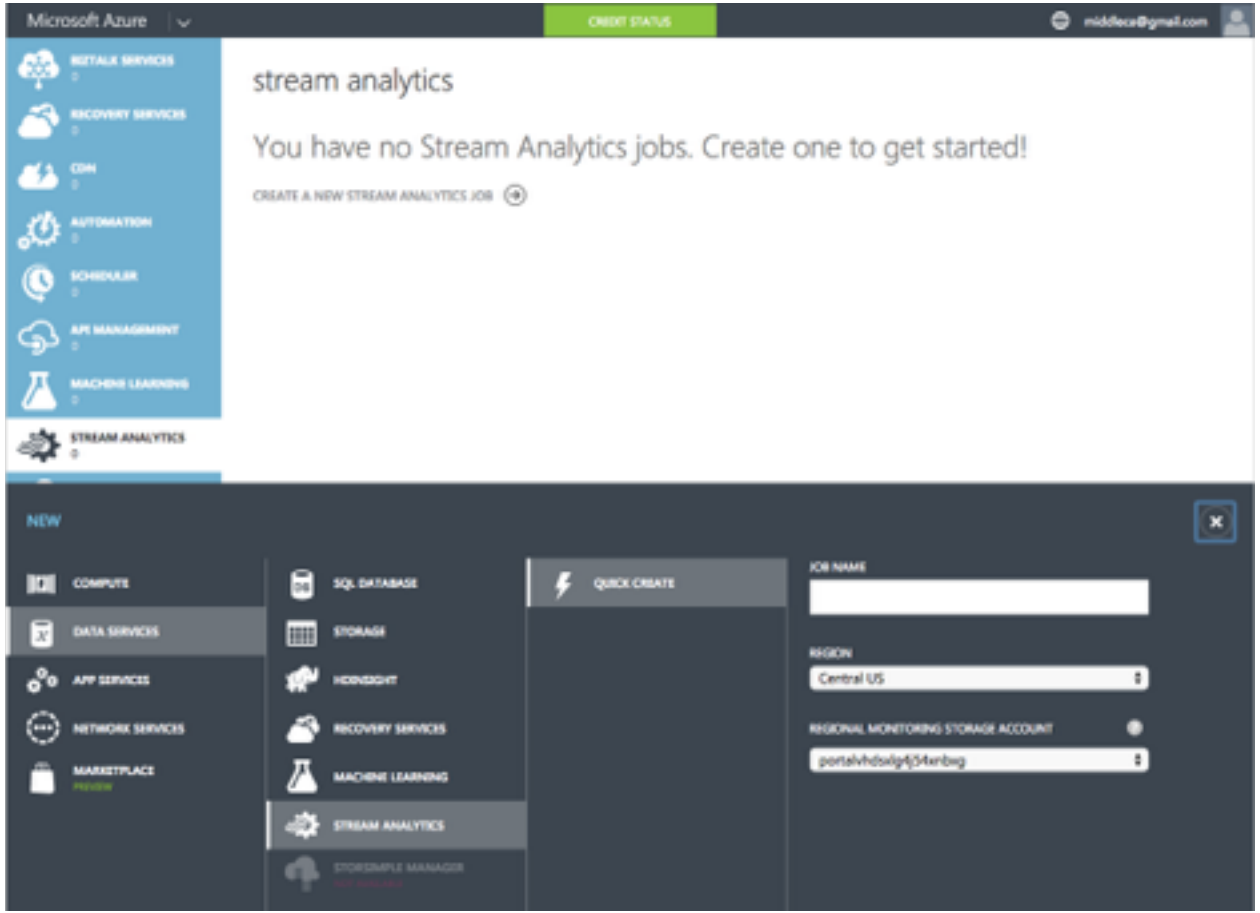
Power BI

Logic Apps

Web/Mobile App


Big Data
Near Real-time Analytics
Data
Ingestion
Machine Learning
Gateway
Sensors
Sensors
Apps and online dashboards

Getting data from Event Hubs into your Database



Setting up stream processor

An Input

ADD A SERVICE BUS EVENT HUB

Event Hub settings

INPUT ALIAS

farm-input

SUBSCRIPTION

Use Event Hub from Current Subscription

CHOOSE A NAMESPACE

katespetes (Central US)

CHOOSE AN EVENTHUB

sensors

EVENT HUB POLICY NAME

RootManageSharedAccessKey

CHOOSE A CONSUMER GROUP

$Default

A query to bind them

query

```
1 SELECT
2     temp, published_at, coreid
3 INTO
4     [coop-output]
5 FROM
6     [coop-input]
```

An Output

ADD A SQL DATABASE

SQL Database Settings

OUTPUT ALIAS

farm_sql_output

SUBSCRIPTION

Use SQL Database from Current Subscription

CHOOSE A DATABASE

spurk-db1

SERVER NAME

zi6yseoh42

USERNAME

dbadmin

PASSWORD

••••••••••••••••••••••••••••••••••

TABLE

farm_data

The result!
We have data!

temp1	temp2	humidity	pressure	altitude	wind_mph	soilTemp	published_at (yyyy-MM
77.40078	78.012497	63.572449	920	754.593201	5.297912	65.525002	2015-09-22 15:29:20.
77.091896	77.787498	63.389343	914.75	750.287109	1.717622	65.525002	2015-09-22 15:30:21.
76.956764	77.5625	64.114136	915	748.851746	1.473023	65.525002	2015-09-22 15:31:22.
76.956764	77.5625	64.198059	913.25	749.671936	1.789968	65.525002	2015-09-22 15:32:23.
76.898842	77.449997	64.632935	914.5	749.877014	5.424651	65.525002	2015-09-22 15:33:24.
76.937454	77.449997	64.838928	918	752.337646	5.200401	65.525002	2015-09-22 15:34:24.
76.937454	77.5625	65.617126	916.25	751.92749	1.642848	65.525002	2015-09-22 15:35:25.
76.76371	77.449997	64.259094	911.25	747.211304	3.533801	65.525002	2015-09-22 15:36:26.
76.609268	77.224998	64.358276	911.75	747.416382	4.834435	65.525002	2015-09-22 15:37:27.
76.705795	77.337502	64.655823	911	747.621399	0.687037	65.525002	2015-09-22 15:38:28.
76.628578	77.224998	65.182251	907.5	744.95575	5.598131	65.525002	2015-09-22 15:39:28.
76.165253	76.887497	65.69342	905.75	742.905212	4.171916	65.525002	2015-09-22 15:40:29.
76.223167	76.775002	66.105408	904.5	741.674866	0.711305	65.300003	2015-09-22 15:41:30.
76.14595	76.775002	65.998596	902.75	740.44458	0.472191	65.525002	2015-09-22 15:42:30.
76.10733	76.662498	65.83075	902.75	741.674866	0.770802	65.525002	2015-09-22 15:43:30.
75.74054	76.4375	66.044373	903.75	741.674866	2.957113	65.525002	2015-09-22 15:44:30.
75.759842	76.4375	66.090149	902.75	741.674866	0.397595	65.300003	2015-09-22 15:45:30.
75.837067	76.4375	66.029114	904	741.264771	3.874433	65.300003	2015-09-22 15:46:31.

now lets write some code!

Insert movie magic coding scene here.

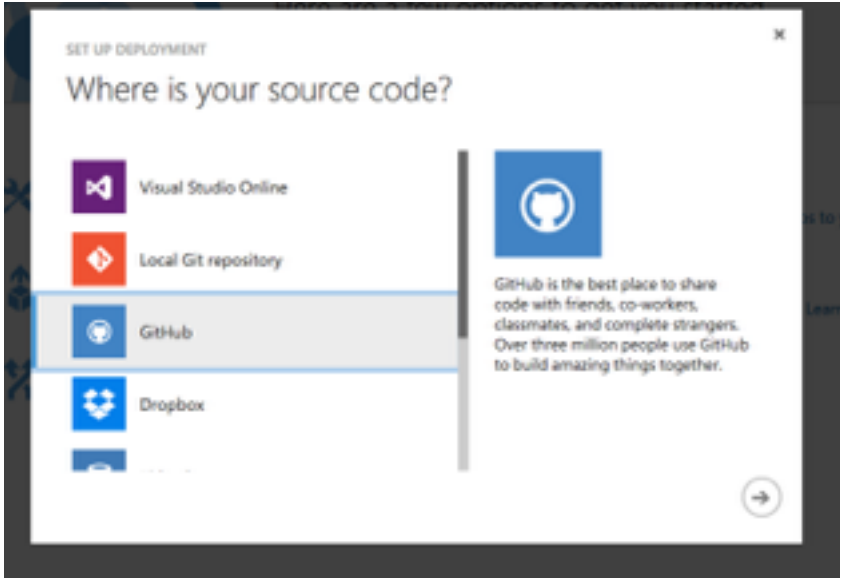
It was cool, ask me about it after or checkout the source!

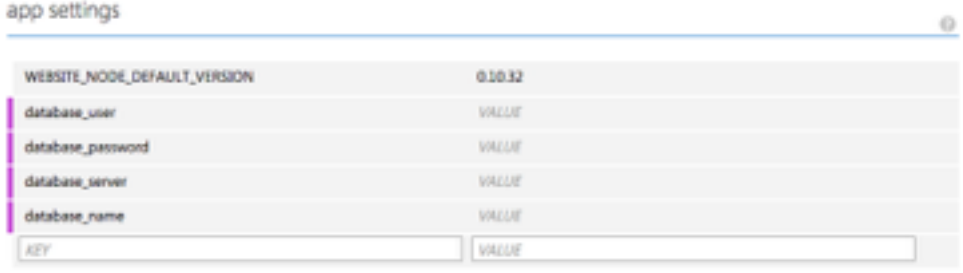
https://github.com/dmiddlecamp/petesfarm

```
dbQuery: function(params, tableName, orderColumn, allowedColumns) {
    try {
        if (typeof params.param == "function") {
            //we got passed a req, instead of just an object.
            params = DataLogic.getParams(params);
        }

        var count = params.count;
        var ascDesc = params.sort;

        var userColumns = allowedColumns;
        var columnsParam = params.columns;
        if (columnsParam) {
            userColumns = columnsParam.split(",");

            //sanitize your inputs kids!
            userColumns = utilities.filterListInList(allowedColumns, us
        }

        var query = "select "
            + "top " + count + " "
            + userColumns.join(", ") +
            " from " + tableName + " order by " + orderColumn + " " + a

        return Database.query(query);
    }
    catch (ex) {
        console.error("dbQuery error! ", ex);
        return when.reject(ex);
    }
},

coopQuery: function(req) {
    var allowedColumns = "temp,published_at".split(",");
    return DataLogic.dbQuery(req, "coop", "published_at", allowedColumn
        .then(function(records) {
            records = Formatters.bruteForceFilter(records, "temp", -100
            return when.resolve(records);
        });
```

We have an app, lets deploy!

- We want this to be easy to maintain
- don't commit secrets into git!
- minimal effort to update, anyone should be able to update it
- oh hey integration with our git repo!

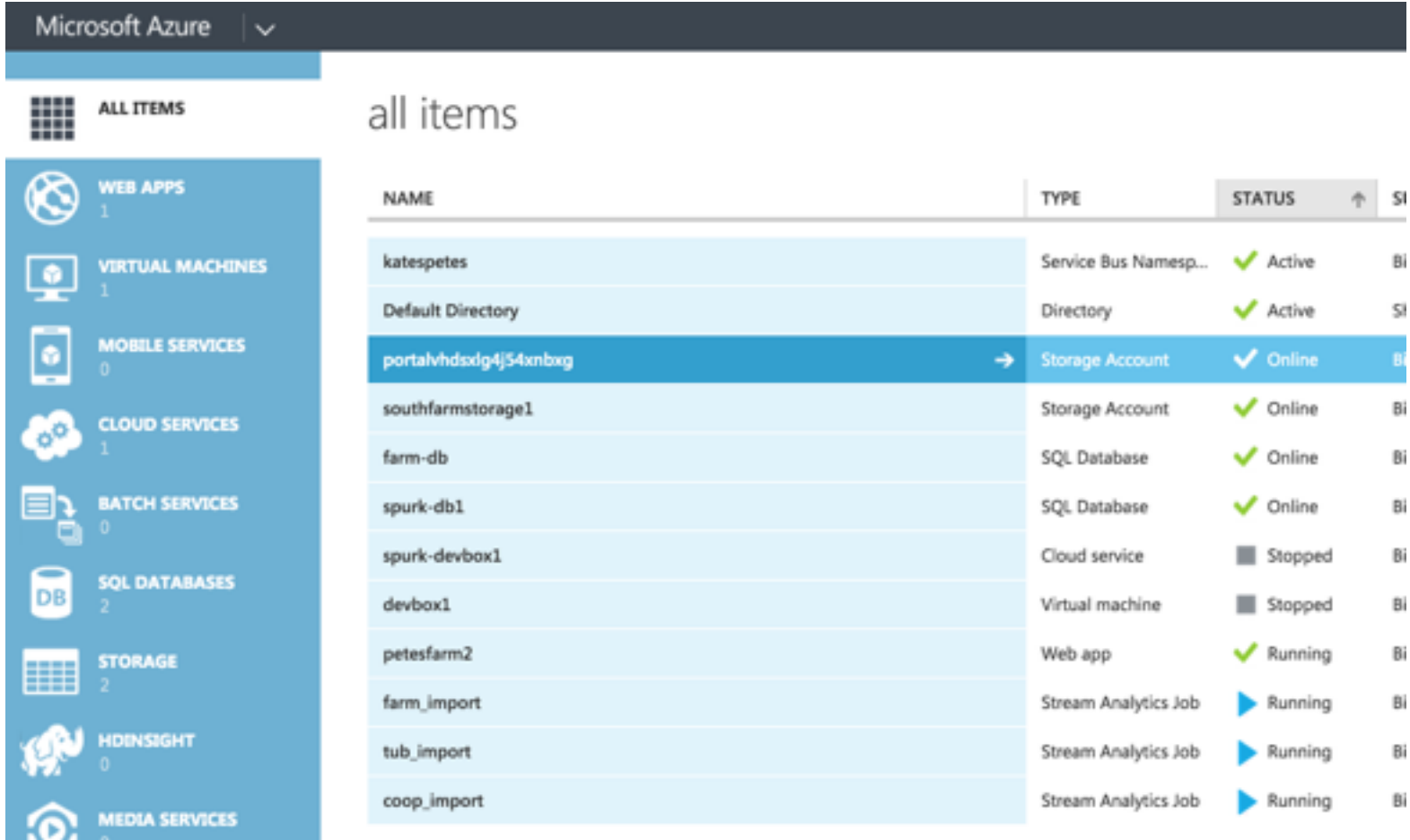




Heroku style!

```
$ git push azure master
Counting objects: 5, done.
Delta compression using up to 8 threads.
Compressing objects: 100% (3/3), done.
Writing objects: 100% (3/3), 288 bytes | 0 bytes/s, done.
Total 3 (delta 2), reused 0 (delta 0)
remote: Updating branch 'master'.
remote: Updating submodules.
remote: Preparing deployment for commit id 'e336af1a4e'.
remote: Generating deployment script.
remote: Running deployment command...
remote: Handling node.js deployment.
remote: KuduSync.NET from: 'D:\home\site\repository' to: 'D:\home\site\wwwroot'
remote: Copying file: 'package.json'
remote: Using start-up script website/bin/www from package.json.
remote: Generated web.config.
remote: Node.js versions available on the platform are: 0.6.17, 0.6.20, 0.8.2, 0.8.19, 0.8.26, 0.8.27, 0.
remote: Selected node.js version 4.1.0. Use package.json file to choose a different version.
remote: Updating iisnode.yml at D:\home\site\wwwroot\website\bin\iisnode.yml

remote: ...............
remote: Finished successfully.
remote: Deployment successful.
```

What did we just do?



Quick live demo?!

–Johnny Appleseed

Weather

(last heard: a minute ago)

79 Air Temp

65 Soil Temp

56 Humidity

0 Rain

0 Wind

Hot Tub

(last heard: 10 minutes ago)

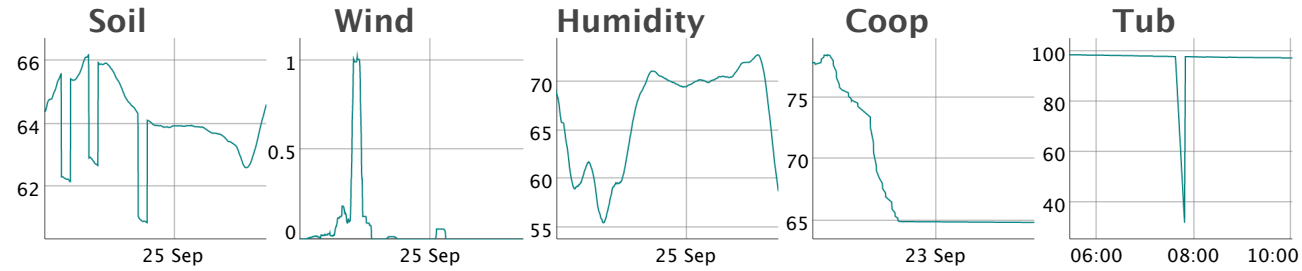
97 Tub Temp

Coop

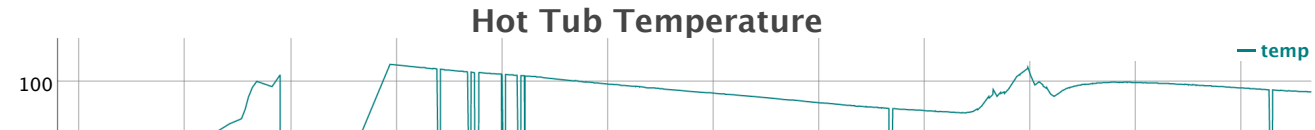
(last heard: 2 days ago)

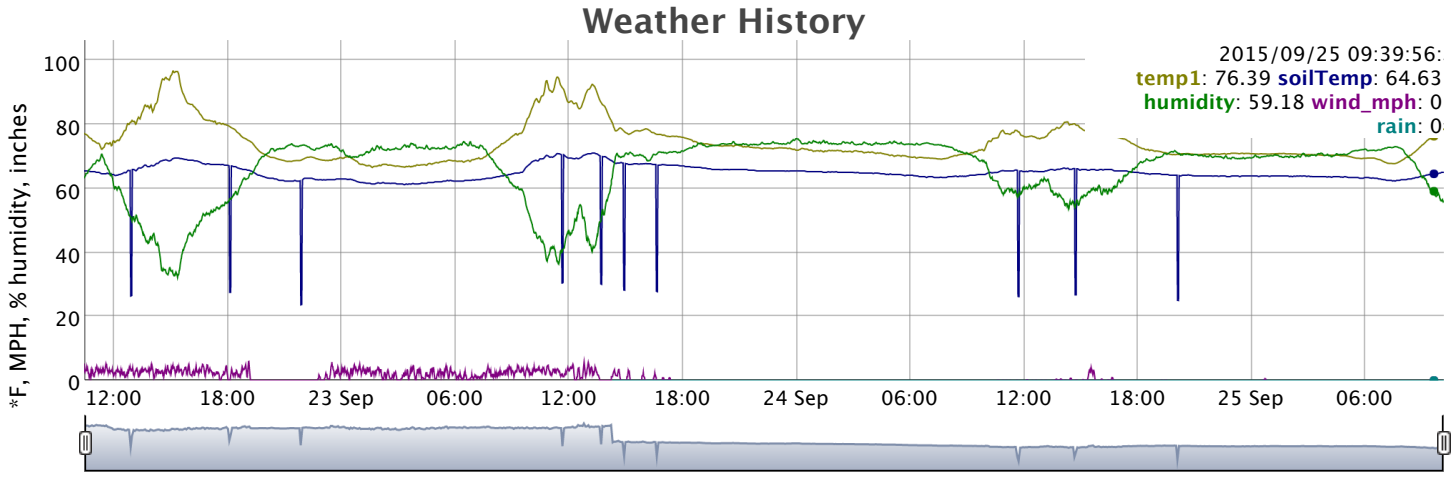
65 Coop Temp

Recent Trends

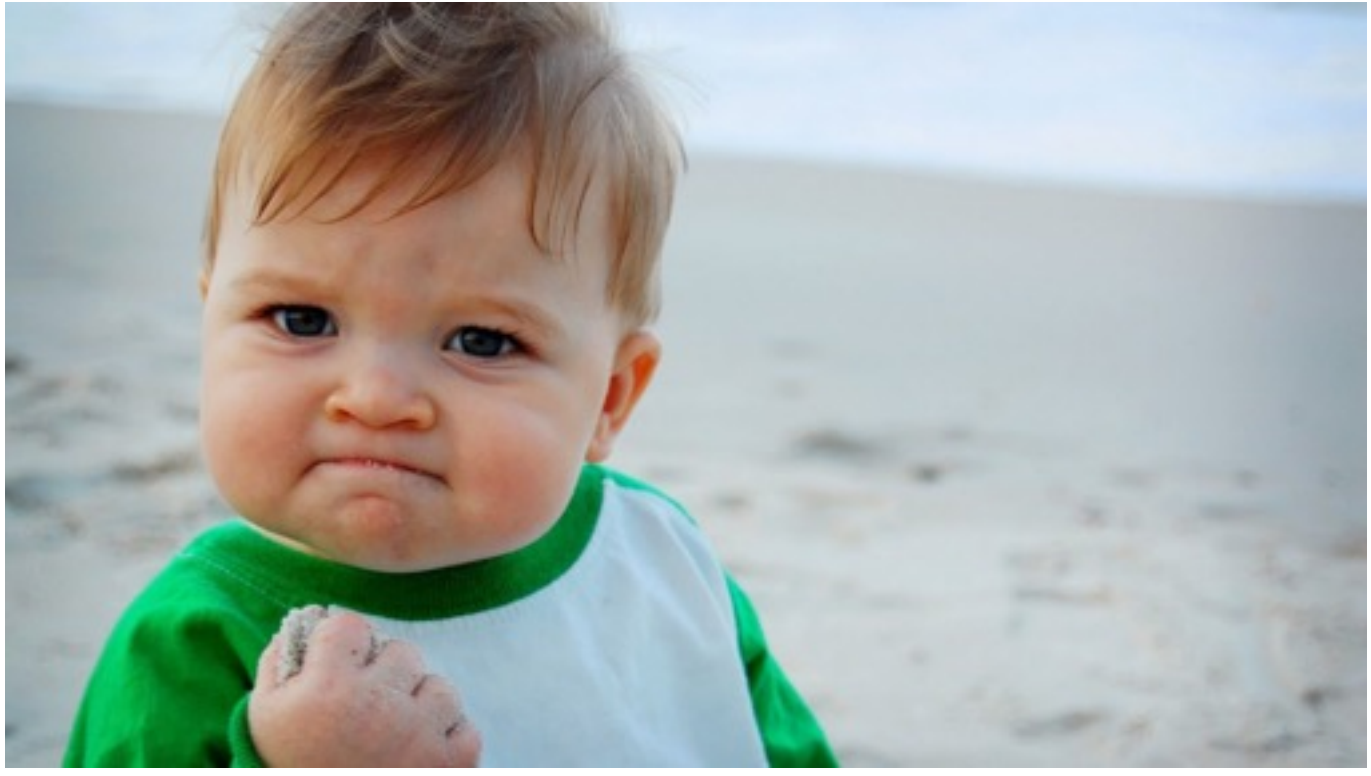


Long Trends




Weather History
2015/09/25 09:39:56:
temp1: 76.39 soilTemp: 64.63
humidity: 59.18 wind_mph: 0
rain: 0
*F, MPH, % humidity, inches
100
80
60
40
20
0
12:00
18:00
23 Sep
06:00
12:00
18:00
24 Sep
06:00
12:00
18:00
25 Sep
06:00

Air Pressure History
pressure
pressure
950
900
850
800
750
700
12:00
18:00
23 Sep
06:00
12:00
18:00
24 Sep
06:00
12:00
18:00
25 Sep
06:00



Yeah!

Future Improvements!

Hot Tub!

baby sleep tracker (is the baby asleep or not, determines if the hot tub can be used?)

Magic hot-tub thermometer! ->

Fun!

chicken audio feed

chicken audio FFT

twilio phone number (“dial-a-farm")

Water usage!

flow sensor / soil moisture sensors

ph sensor, dissolved oxygen sensor, water conductivity

Plant Optimization!

temperature sensor in every growing bed / farm heat map

helps place plants, figure out how much sun they're getting, etc.

Meet John

Like you he makes stuff

R-13
EcoTouch
R-13
EcoTouch
PINK
INSULATION

SAUNA
Changing
ROOM

CHOP WOOD
CARRY WATER

“Nice sauna! Can I throw some sensors in there?”

–Me

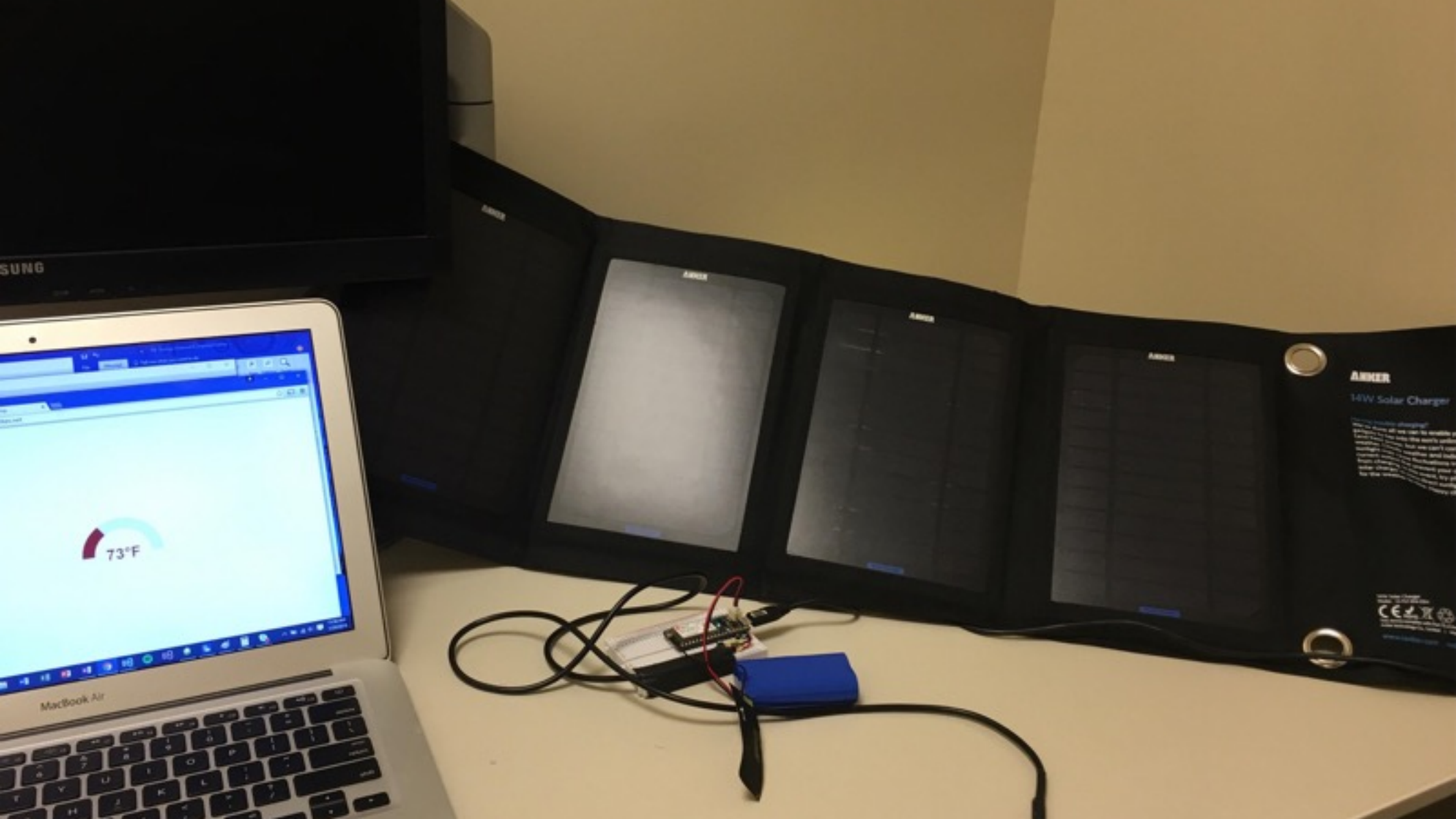
Lets scope this out

- What temp is it right now?
- Should I swing by the sauna?
- Mobile and remote
- Low impact, no maintenance

PKCELL
ICR18650 4400mAh 3.7V

Electron

- like the photon but cellular
- cool battery hotness
- comes with a SIM
- Particle == MVNO
- 2G and 3G
- that flexibility tho
- low cost ($49) !
- reusable!
- <more>


SUNG
73°F
MacBook Air
ANKER
14W Solar Charger

u-blox
Model: SARA-G350
801200.04111.000
IMEI: 353161071128590
CE 1909

firmware

1) Read the temperature
2) Publish it
3) Be smart about battery and data

```
void updateTemp() {
    dallas.requestTemperatures();
    float celsius = dallas.getTempCByIndex( 0 );
    temp = (celsius * 9.0)/ 5.0 + 32.0; // C to F
    tempInt = (int) temp;

    if (millis() - lastPublish > publishRate) {
        publishTemp();
    }
}
```

```
void publishTemp() {

    if (tempInt > 0) {
        Particle.publish("tempf", String(tempInt));
    }

    lastPublish = millis();
}
```

```
void publishToAzure() {

    if (millis() - lastAzurePublish > AZURE_PUBLISH_RATE) {
        char buffer[100];
        snprintf(buffer, sizeof(buffer), "{\"Temp\":\"%f\"}",temp);

        analogWrite(led, 50);
        delay(500);
        ams.create(table, buffer);
        analogWrite(led, LOW);

        lastAzurePublish = millis();
    }

}
```

```
int updateRate(String rate) {

    publishRate = rate.toInt();

    if (temp < 60) {
        publishRate = 10 * 60 * 1000; // sleepytime
    } else if (temp < 80) {
        publishRate = 1 * 60 * 1000; // daytime and heated
    } else if (temp < 100) {
        publishRate = 30 * 1000; // heating up
    } else {
        publishRate = 5 * 1000; // sauna mode
    }
}
```

server

1) Login to Particle cloud
2) Listen for temp events
3) Update clients with socket.io

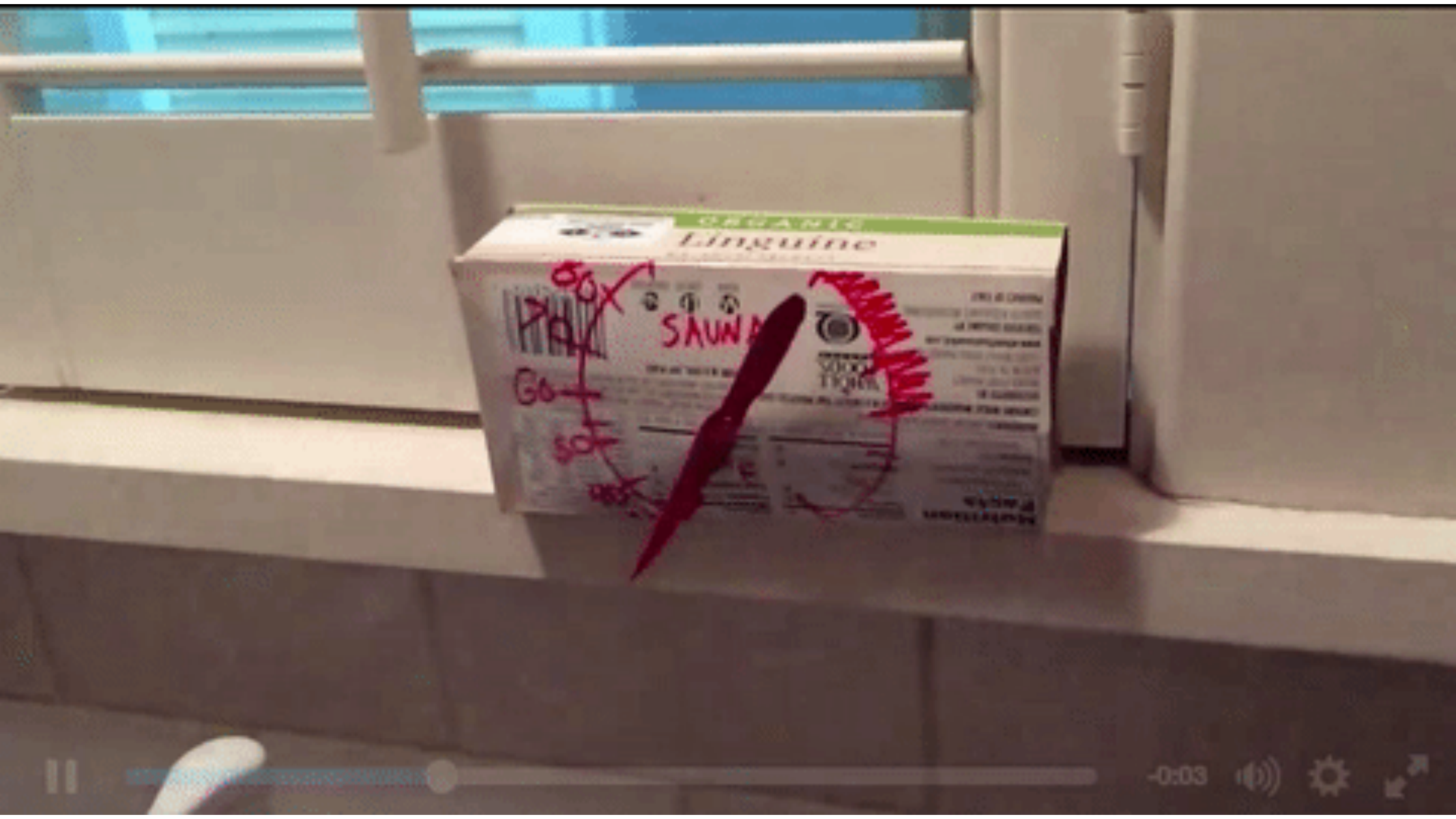
```
spark.on('login', function() {


spark.getEventStream('tempf', process.env.ParticleDeviceId, function(msg) {
    if (msg) {
        console.log("Event: " +msg.name +":" + msg.data);

        lastTemp = msg.data;
        lastPublish = Date.now();

        publish();
    }
});


function publish() {

    if (lastTemp) {
        io.emit('tempf',  {tempf: lastTemp, updated: lastPublish});
    }
}
```

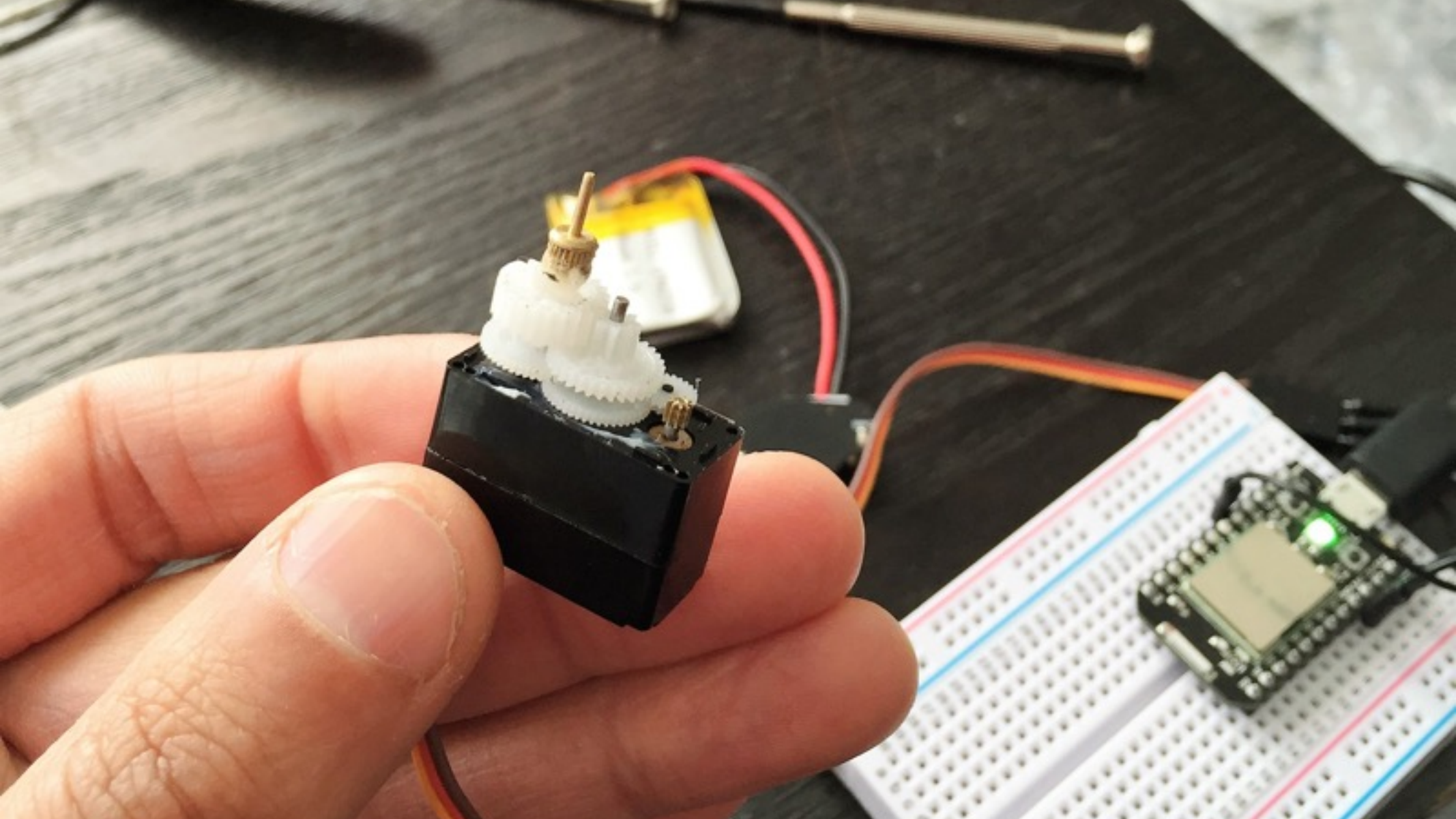
https://github.com/dwcares/SaunaTemp/

Verizon LTE
7:09 PM
29%
saunatemp.azurewebsites.net
180°F

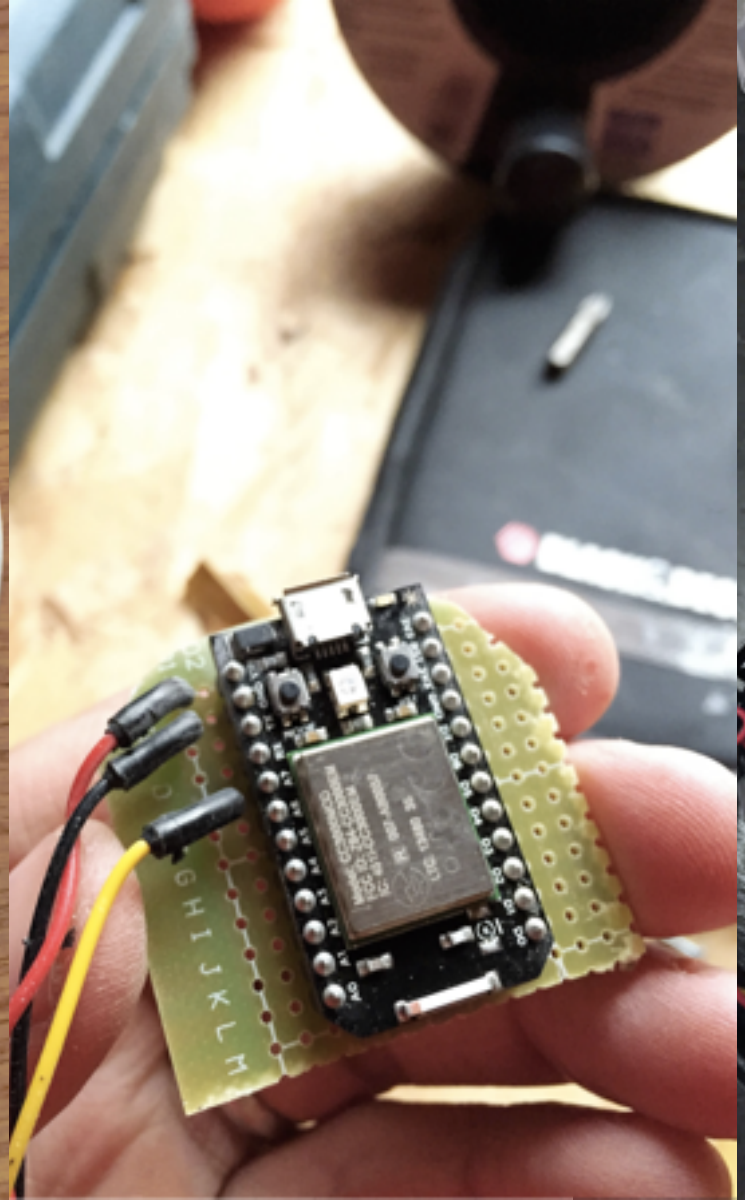
“how about a demo, chap?”

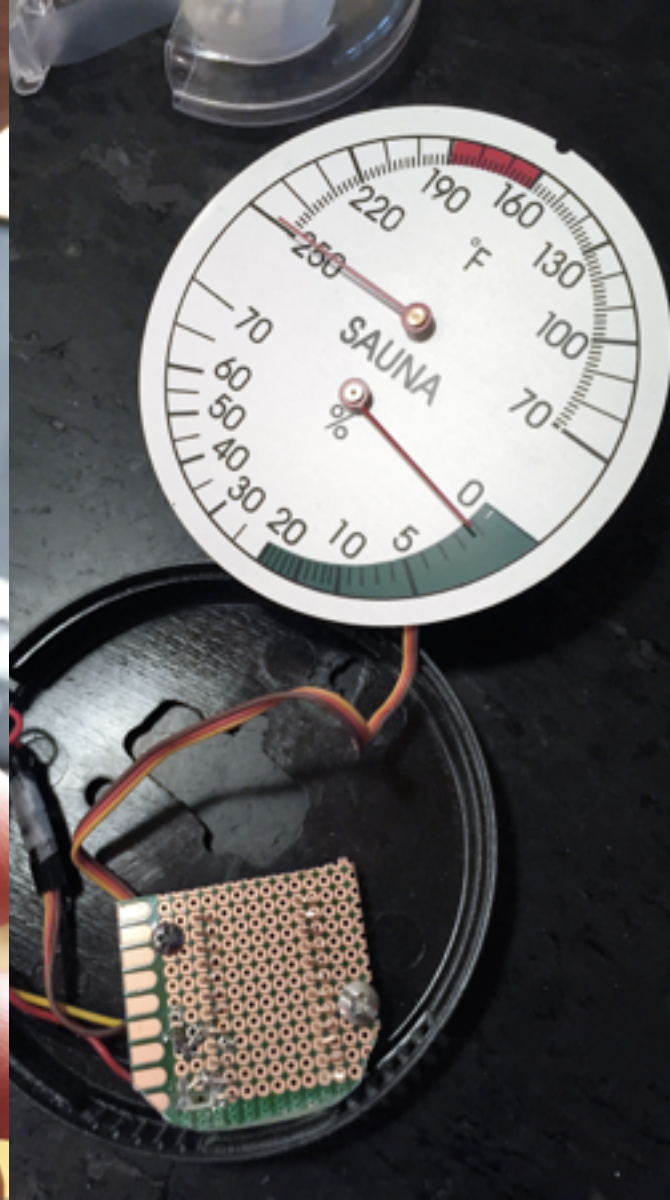
–Johnny Appleseed


ORGANIC
Linguine
SAUNA
-0:03



SAUNA
°F
%
250
220
160
100
70
0
70
60
50
40
30
20
10
5


G H I J K L M


SAUNA
°F
%
250
220
190
160
130
100
70
0
70
60
50
40
30
20
10
5

dashboard

70
65
60
Jan 25, 6AM
Jan 25, 12PM
Jan 25, 6PM
Jan 26, 12AM
Jan 26, 6AM
36
35
34
33
32
31
30
29
28
27
Jan 25, 6AM
Jan 25, 12PM
Jan 25, 6PM
Jan 26, 12AM
Jan 26, 6AM

Future Improvements!

How many seats empty

Auto-temp control

Alerts and SMS

Registration/checkin

Body stats and vitals

Testimonials

Meet Alice

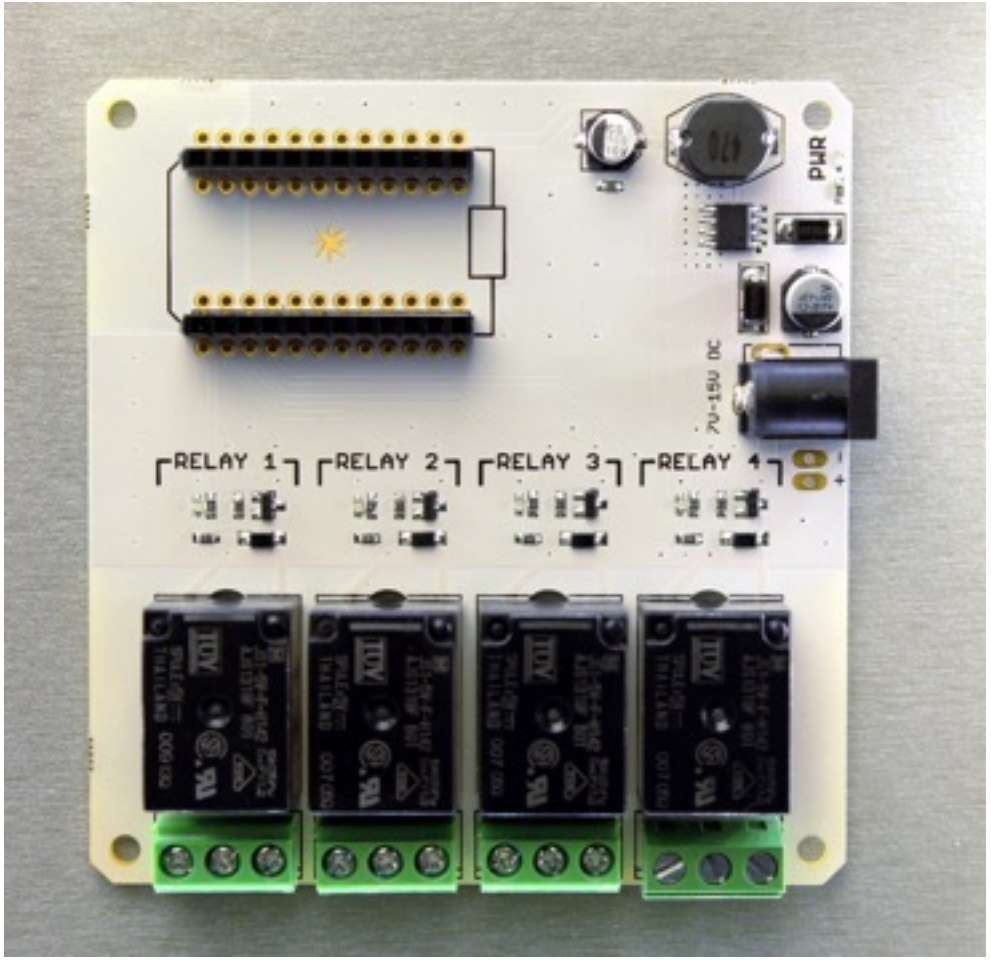
Alice Pritikin Steinglass
November 30, 2015 ·

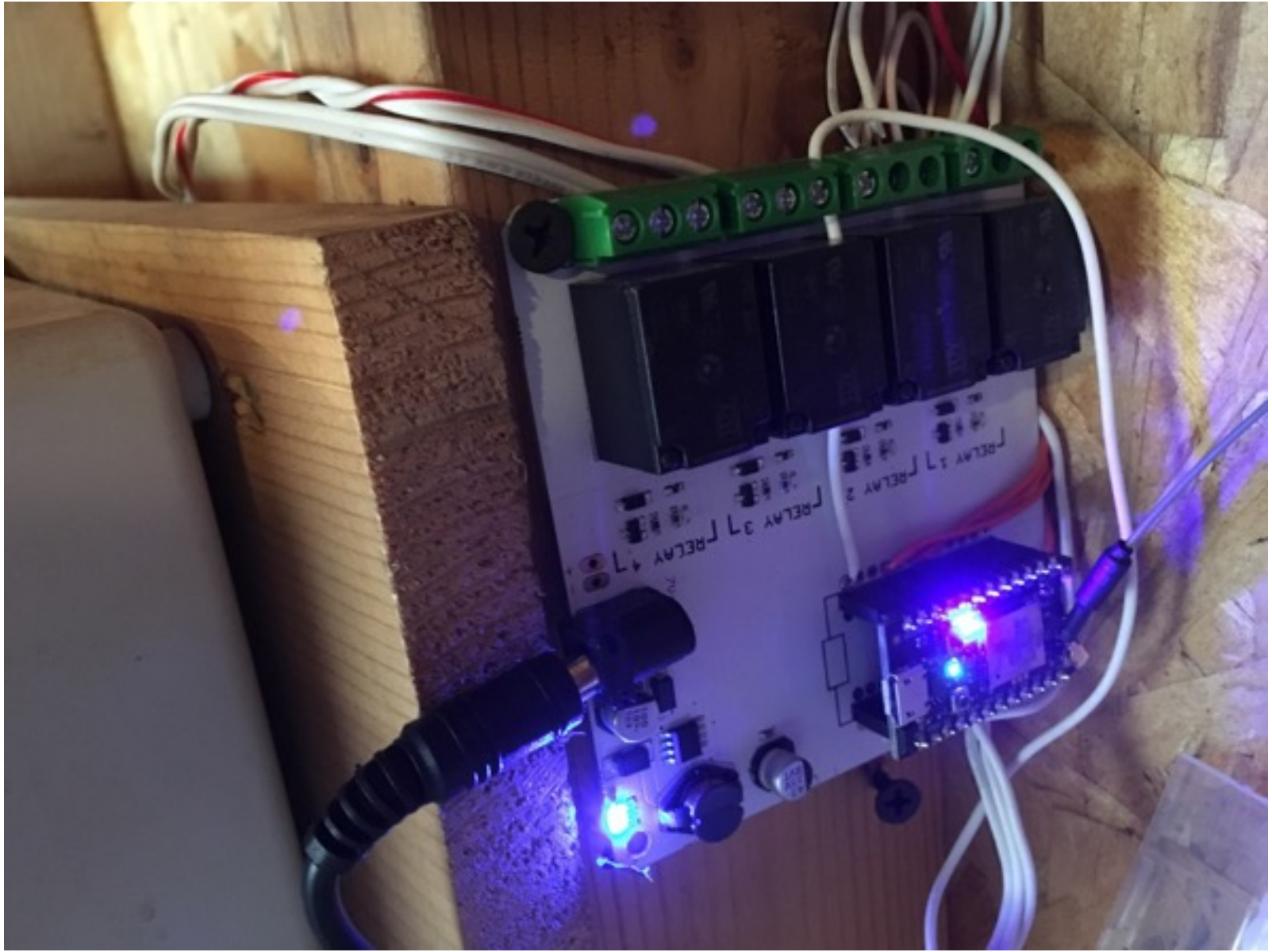
Lived here for four years. Finally got around to hanging tennis balls from the garage ceiling. Instant three feet of usable space addition.

Lets scope this out

- Where should I park? When should I stop?
- What cars are parked?
- Open doors without an opener
- Security alerts
- Robust connectivity and reliable

28015
REV A
www.parallax.com
ACT
PARALLAX
PING)))
GND
5V
SIG


PWR
7V-15V DC
RELAY 1
RELAY 2
RELAY 3
RELAY 4


RELAY 1
RELAY 2
RELAY 3
RELAY 4

AUTOMATIC
GARAGE DOOR
& FIREPLACES
NEW RICHMOND 246-4458
MPLS. 571-2525
APPLE VALLEY 891-3667
MONTICELLO 295-4343
LOCK
LIGHT

COM.
NC.
NO.

firmware

1) Read the ping sensor
2) Smooth the data
3) Publish on a regular interval

```
void updateTemp() {
    dallas.requestTemperatures();
    float celsius = dallas.getTempCByIndex( 0 );
    temp = (celsius * 9.0)/ 5.0 + 32.0; // C to F
    tempInt = (int) temp;

    if (millis() - lastPublish > publishRate) {
        publishTemp();
    }
}
```

```
int updateRate(String rate) {

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    }
}
```
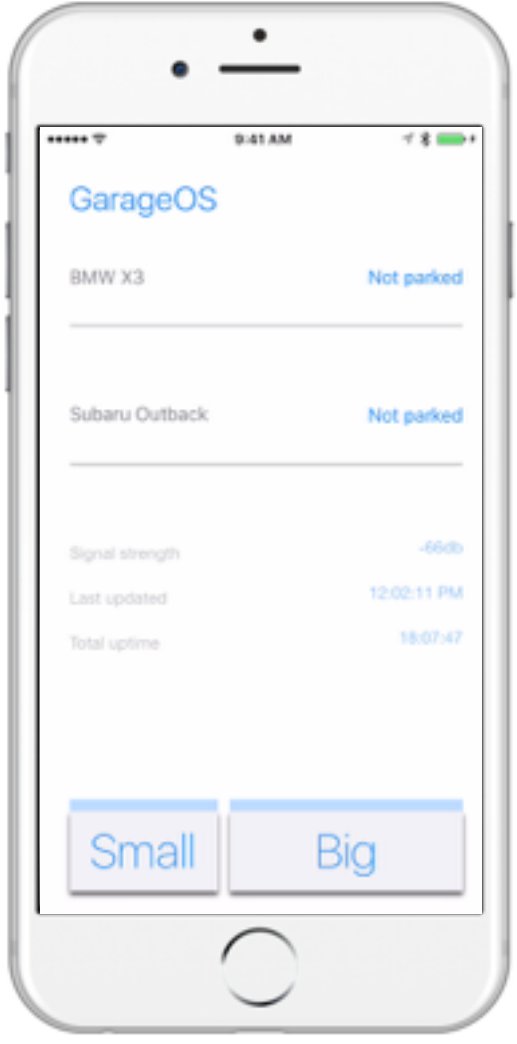

```
void publishToAzure() {

    if (millis() - lastAzurePublish > AZURE_PUBLISH_RATE) {
        char buffer[100];
        snprintf(buffer, sizeof(buffer), "{\"Temp\":\"%f\"}",temp);

        analogWrite(led, 50);
        delay(500);
        ams.create(table, buffer);
        analogWrite(led, LOW);

        lastAzurePublish = millis();
    }

}
```

1) Particle iOS SDK
2) Listen for device events
3) Show changes in the UI
4) Call Particle.functions to open the doors



Future Improvements!

Auto-open/close on approach

Log and predict arrival times

Door open alerts

Second car distance

what will you build?

mic drop

a thing, such as, the internet.

PREPARE YOURSELF

1.) Have a smartphone!

(if you don't have one, make a friend!)

2.) Get a photon and a USB cable

*(if you don't have one, wave to **David**!)*

PREPARE YOUR PHONE

Install the Particle App!

(available for free on iOS and android)

PREPARE YOUR PHOTON!

1.) Plug in that USB cable

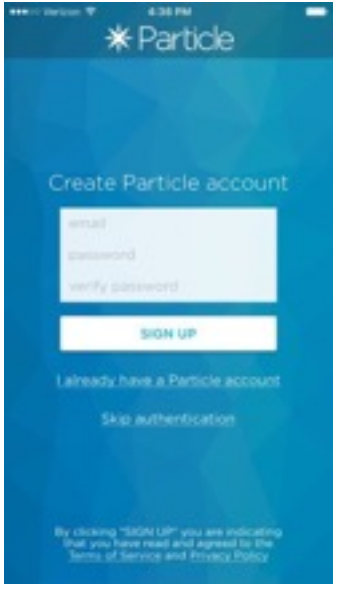
(big side to your computer, small side to the photon)

2.) Blinking BLUE

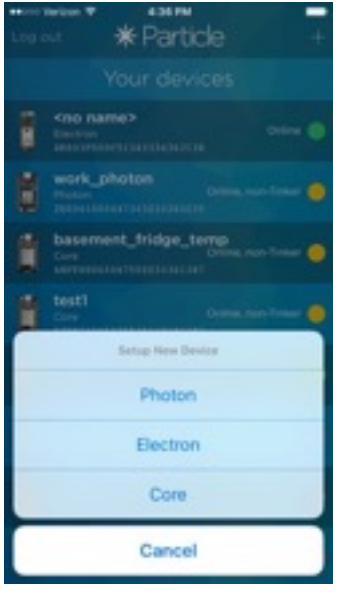
(my god, it's full of colors)

USE that app!

Particle
Get Started


Particle
Create Particle account
SIGN UP
I already have a Particle account
Skip authentication

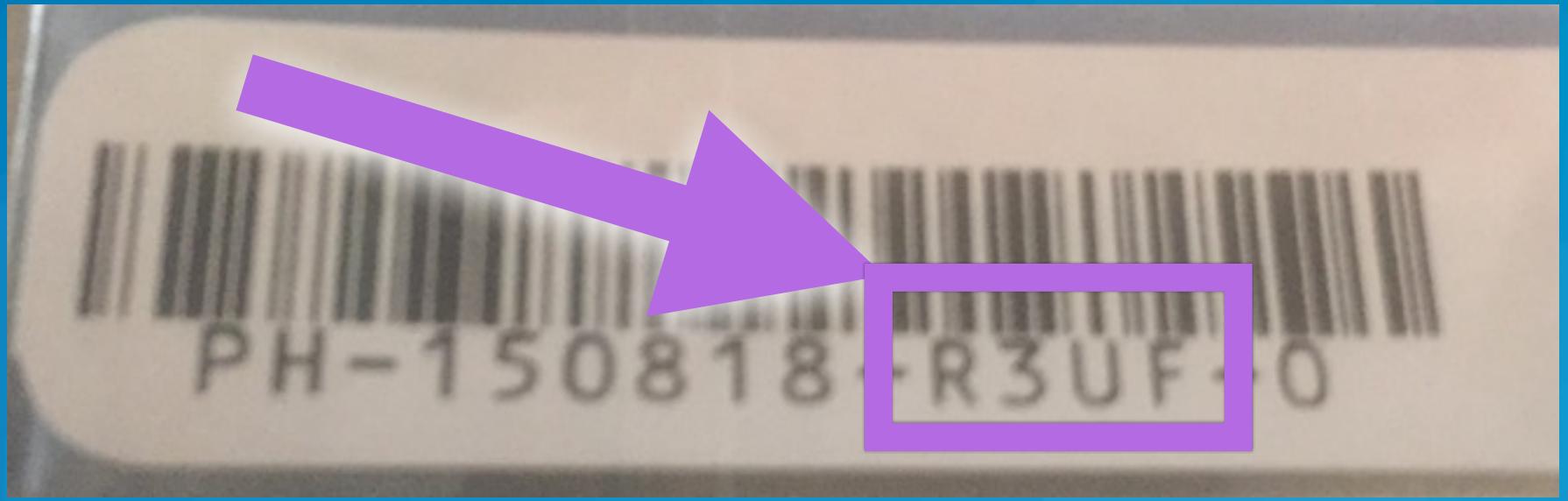
Log out
Particle
Your devices
<no name>
work_photon
basement_fridge_temp
test1
maker1_DECK
<no name>
speaker_test2
bluz


Log out
Particle
Your devices
<no name>
work_photon
basement_fridge_temp
test1
Setup New Device
Photon
Electron
Core
Cancel

Cancel
Particle
Log out
1 Plug in your Particle device to power it on
2 The on-board LED should be blinking blue. If not, hold the mode button for 3 seconds
3 Make sure your iOS device is connected to the Internet
READY

Cancel
Particle
1 Tap Home > Settings > Wi-Fi
2 Make sure Wi-Fi is turned on, and choose the network below:
Photon-XXXX
3 Once connected, return to this app
SHOW ME HOW

Which photon? USE THE BARCODE!



Which wifi network?

particle24

Control an LED

THANK YOU!

GOOD NIGHT

go to **build.particle.io**

lets make some data

it’s really hard, ready?

Particle.publish(“name”, “value”);

lets make some data

```
Particle.publish(“iotfuse_rssi", String(WiFi.RSSI()));
```

show me my data!

go to **dashboard.particle.io**

lets use our data

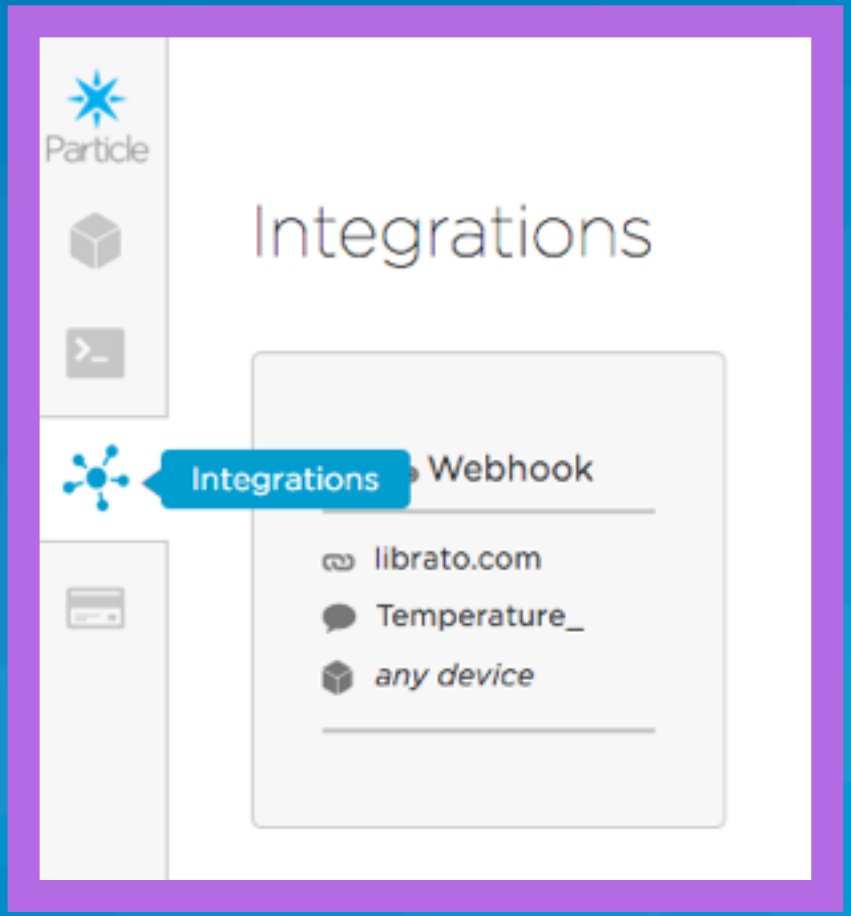
time for webhooks!

Webhooks, *and you*

- What's an internet?
- What's a web?
- What's a web request?
- What's an API?
- What's a RESTful API?

- What's a webhook?
- How do I webhook?
- **dashboard.particle.io** -> then click on integrations

dashboard.particle.io



dashboard.particle.io

Integrations > New Integration

Webhook

Push particle data to other web services in real-time

?

Top-Secret Integration coming soon

A new integration to be announced in the near future!

?

Top-Secret Integration coming soon

A new integration to be announced in the near future!

Integrations > New Webhook

Docs

Webhook Builder Custom JSON

Event Name
iotfuse_rssi

URL
https://metrics-api.librato.com/v1/metrics

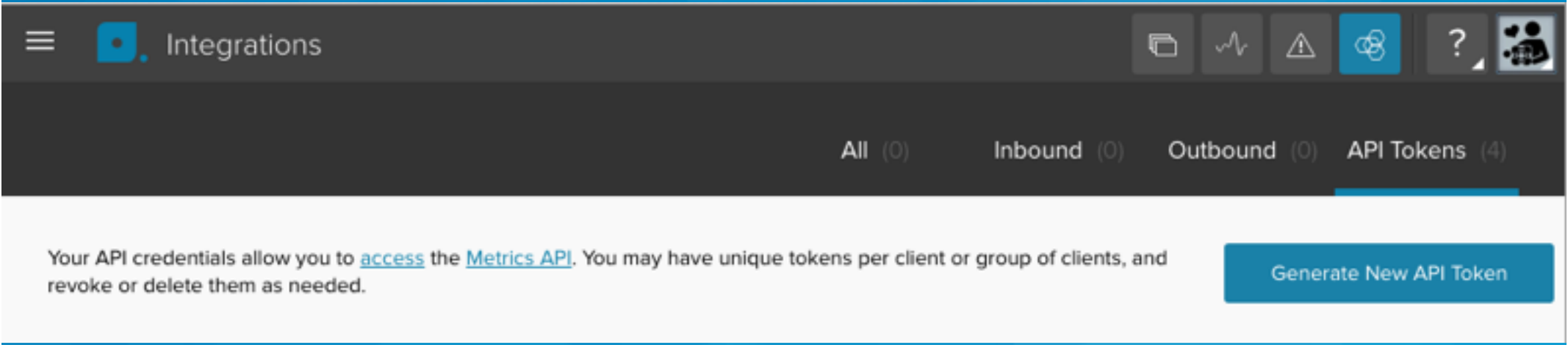
Request Type
POST

Device
Any

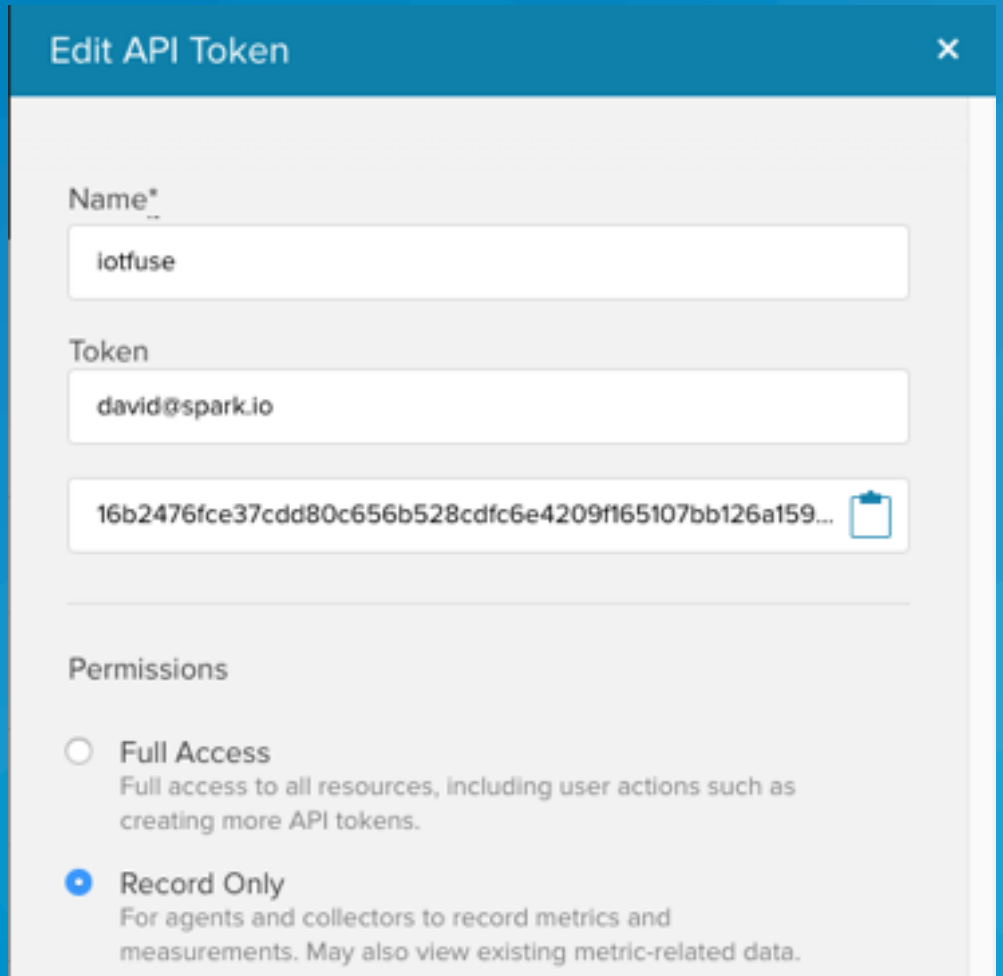
Advanced Settings

CREATE WEBHOOK

metrics.librato.com/tokens



getting the token from libretto



set the token in your hook

HTTP BASIC AUTH

Username
david@spark.io

Password
16b2476fce37cdd80c656basdfasdfawfaew7bb126a1595242c6azxcvzxcv

set the template for the request

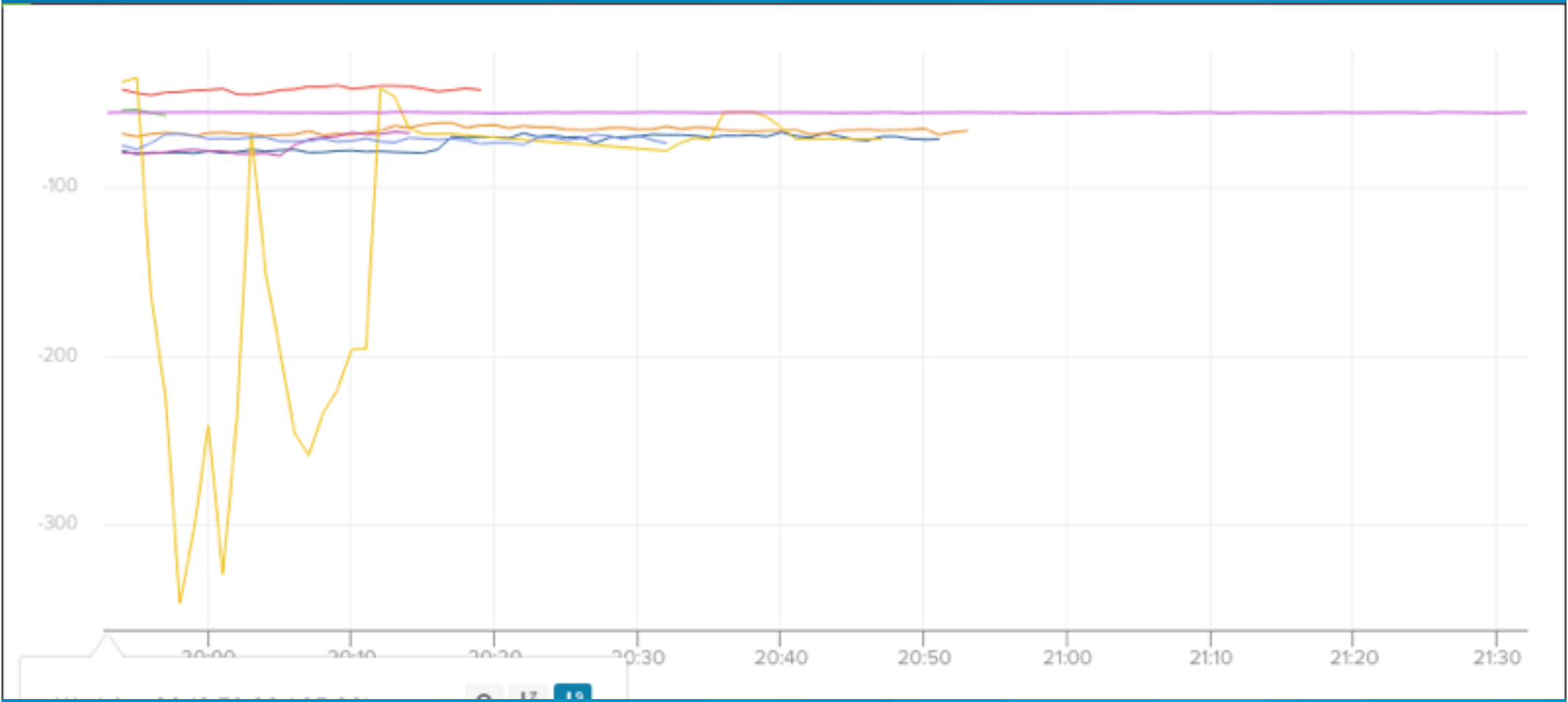
Advanced Settings

SEND CUSTOM DATA

None JSON Form

```
"gauges":
[
    {
        "name": "{{SPARK_EVENT_NAME}}",
        "value": "{{SPARK_EVENT_VALUE}}",
        "source": "{{SPARK_CORE_ID}}"
    }
]
```

lets look at our data!



questions?

Urban Farming IoT Workshop

Bring IoT where no one has been before

and

David Middlecamp
@dmiddlecamp

David Washington
@dwcares