An IoTa of IoT:

Micro:bit Magic & Photon Phun!

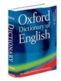
Bill Siever
Washington University in St. Louis

Michael Rogers
Northwest Missouri State University

Outline

- Intros: Us, You
- Background, Motivations, Considerations, & Platforms
- micro:bit Magic
  - Setup & Dev. Environment
  - “Hello, World!”: First Program
  - Broadcast Basics & Firefly Fun
  - Motor Mayhem or Awesome Audio
  - Quick Overview: IoT Insanity
- Photon Phun
  - Blinky & Remote Lights
  - Buttons & Variables
  - Apps & Real IoT

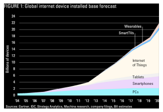
Background



- A network (internet) of sensor-, actuator- and software-equipped devices (things) that share information among themselves as they scheme to take over the world (we may need to work on this last bit)😳
- Home: Lights, Thermostat, Smoke Alarms, Security Systems, Internet of Things Doorbell 😀

Motivation

- Provides a unique outlet for **creativity!** Students can make something ***new***.
- Fun, maker-like experience with tangible artifacts.
- Accessible multi-tier view of a complex, real-world systems.
- Jobs & industry Needs



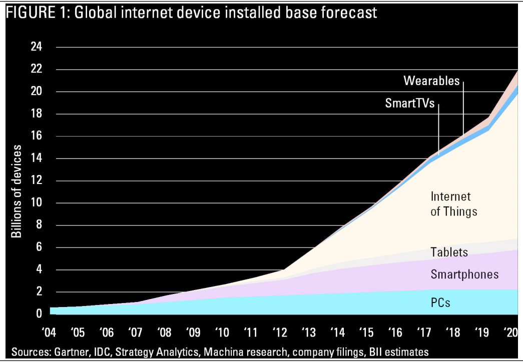


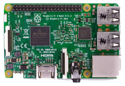
FIGURE 1: Global internet device installed base forecast

Sources: Gartner, IDC, Strategy Analytics, Machina research, company filings, BII estimates

Considerations

- What are your objectives?
- Who's your audience?
- Theoretical? Applied? A hybrid?
- Depth or breadth?

Plethora of Platforms

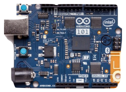


Raspberry Pi

$16; Wi-Fi;Wiring

ESP8266

$<16; Wi-Fi;Wiring



Arduino Variants

$~8-80; Wi-Fi, BLE;Wiring

micro:bit

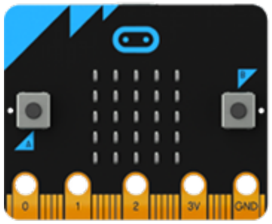
$13; BLE

Photon

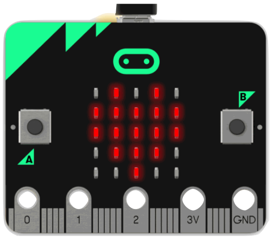
$19; Wi-Fi;Wiring

Intros: the micro:bit

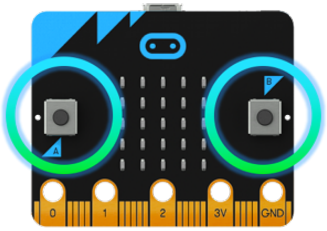
Small



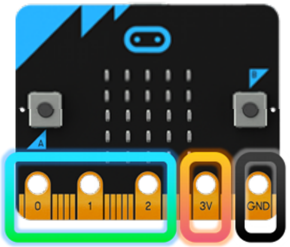
LED Grid



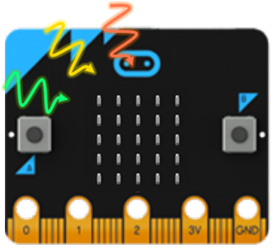
Buttons



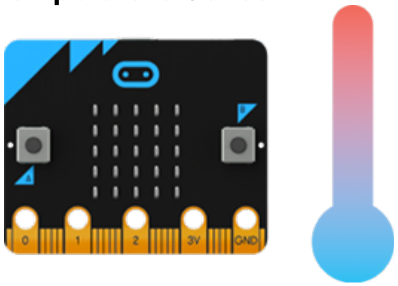
Connectors

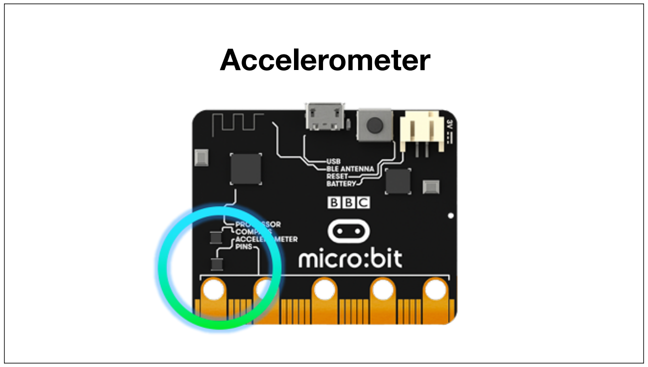


Light Sensor

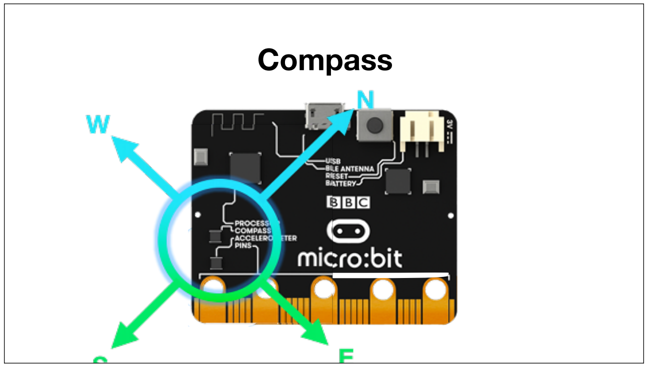


Temperature Sensor

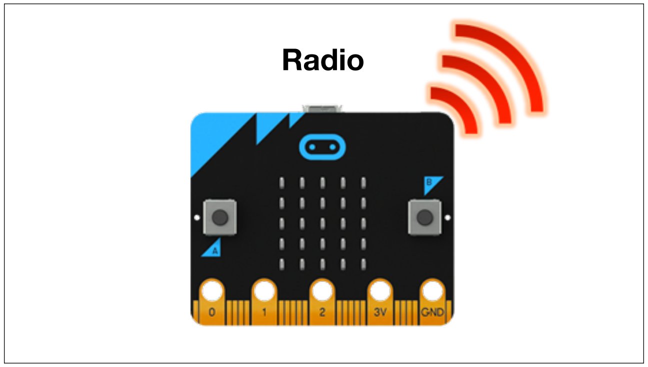




Accelerometer

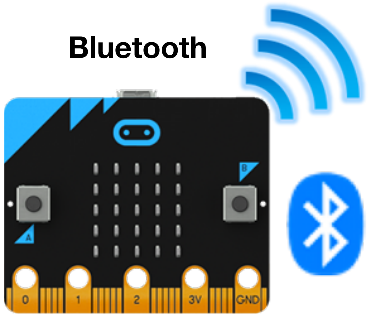


Compass

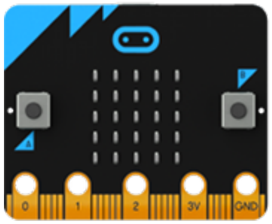


Radio

Bluetooth



Low Cost: ~$13 US

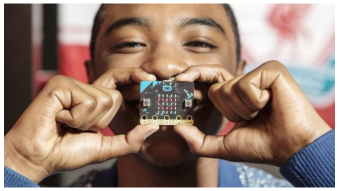


Thanks: Micro:bit Educational Foundation

and Hal Speed

2015

- BBC Make It Digital
- 29 partners
- 1 million micro:bit devices
- 11-12 year olds
- Across the U.K.



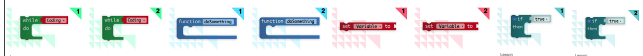
Lessons Aligned to Code.org CS Fundamentals

- Lessons extend the concepts taught in the Code.org curriculum by using micro:bit and MakeCode
  - Course E – Loop and Functions
  - Course F –Variables and Conditionals

Aligned to Code.org® Curriculum

4th Grade Course E

5th Grade Course F



Lesson	Lesson	Lesson	Lesson	Lesson	Lesson	Lesson	Lesson
Course E - Loops 1 - Loops and Animations	Course E - Loops 2 - Nested Loops and Scoreboards	Course E - Functions 1 - A Simple Function for a Superhero	Course E - Functions 2 - Functions for a Digital Pet	Course F - Variables 1 - Variables With A Counter	Course F - Variables 2 - Variables and Emotions	Course F - Conditionals 1 - Conditionals with the Weather Predictor	Course F - Conditionals 2 - Conditionals with Rock Paper Scissors Game

http://microbit.org/teach/code-org-fundamentals/

Sample of Lessons

Lesson	Resources
Answering Machine	• 5 Minute Lesson Plan (pdf) (pptx) • Teacher Notes (pdf) (docx) • Hex File (Tip: Save link for Mac, Save target for PC)
Guess the Number	• 5 Minute Lesson Plan (pdf) (pptx) • Teacher Notes (pdf) (docx) • Hex File
Temperature	• 5 Minute Lesson Plan (pdf) (pptx) • Teacher Notes (pdf) (docx) • Hex File
Die Roll	• 5 Minute Lesson Plan (pdf) (pptx) • Teacher Notes (pdf) (docx) • Hex File

Third-Party Curricula

Microsoft MakeCode Intro to CS
https://aka.ms/intro2cs

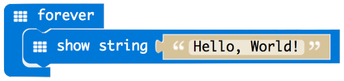
1. Making
2. Algorithms
3. Variables
4. Conditionals
5. Iteration
6. Review/Mini-Project
7. Coordinate Grid System
8. Coordinate Grid System
9. Booleans
10. Music and Arrays
11. Bits, Bytes, and Binary
12. Radio
13. Arrays
14. Independent Final Project

PLTW Gateway:
Computer Science for
Innovators and Makers
https://www.pltw.org/our-program pltw-gateway-curriculum#curriculum-4

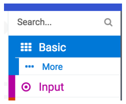
“Hello, World!”: First Program

- Block-based editor
- Built-in simulator
- Deployment to Micro:bit

Icon Indicates
Palette



```
forever
    show string "Hello, World!"
```



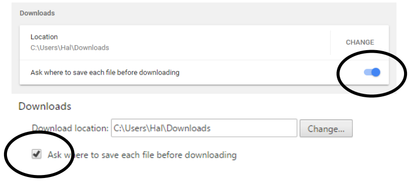
Block Color Indicates Palette

Setup

- Hardware Handout — ***Thanks Microbit Foundation!***
  1. Pull out the micro:bit box / open
  2. Connect via USB cable
- Browser
  1. Open microbit.org
  2. Select “Let’s Code”
  3. Click “Let’s Code” button

Chrome Setup

- chrome://settings/downloads - OR - Show advanced settings…



Downloads

Location
C:\Users\Hal\Downloads

CHANGE

Ask where to save each file before downloading

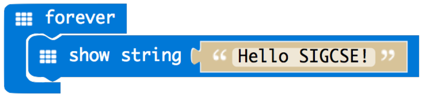
Downloads

Download location: C:\Users\Hal\Downloads Change...

☑ Ask where to save each file before downloading

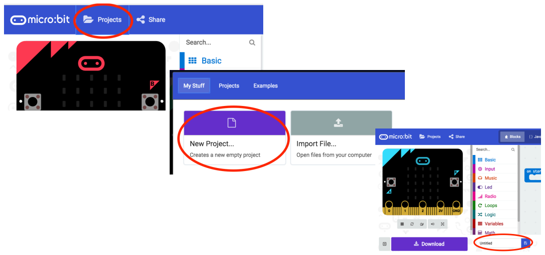
Personalization!

- Hello Bill / Hello Michael / Hello ….



```
forever
    show string "Hello SIGCSE!"
```

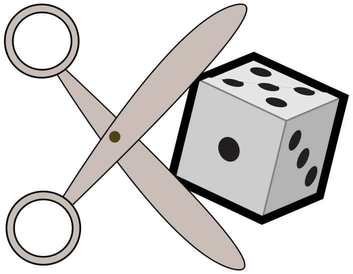
New Project: Projects > New Project…



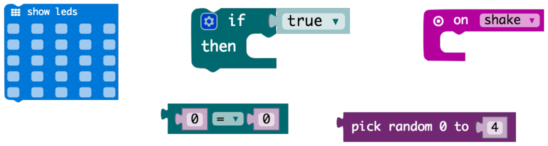
Programming: Logic & Action

- Picking between *three* tough choices
  - Cookie, Cake, Pie
  - Super Strength, Invisibility, Telekinesis
  - …

Obvious Solution…



Parts



show leds

if true then

on shake

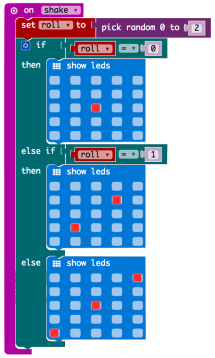
0 = 0

pick random 0 to 4

1. Color indicates Palette
2. Incremental Development:
   Try parts in Simulator

Solution

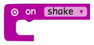
Pro Tip: Blocks with a
button have additional features
(else-if)



```
on shake
  set roll to pick random 0 to 2
  if roll = 0
  then show leds
  else if roll = 1
  then show leds
  else show leds
```

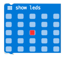
Concepts

- Event driven programming



```
on shake
```

- Bitmapped Graphics

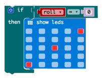


```
show leds
```

- Ranges & Representations

```
pick random 0 to 2
```

- Logic

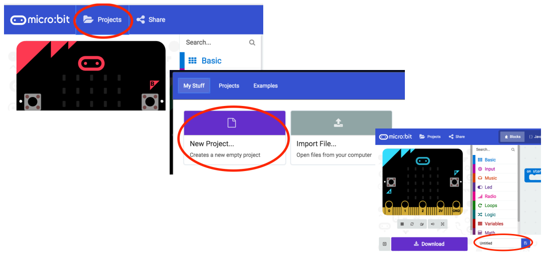


```
if roll = 0
then show leds
```

Pedagogy

- Active Learning
- Discovery Based
- Constructionist

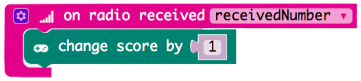
New Project: Projects > New Project…



Broadcast Basics

- Radio Palette: Broadcast Based Radio Transmissions
  - String, Number, Key/Value Pairs, …

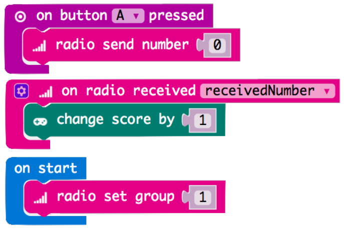
Receiver



```
on radio received receivedNumber
    change score by 1
```

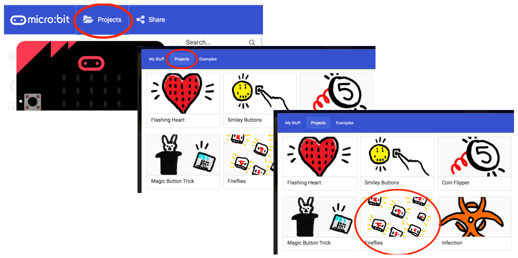
“Game” blocks in “Advanced”
Section of Palette

Full Broadcaster



```
on button A pressed
    radio send number 0
on radio received receivedNumber
    change score by 1
on start
    radio set group 1
```

& Firefly Fun



Concepts

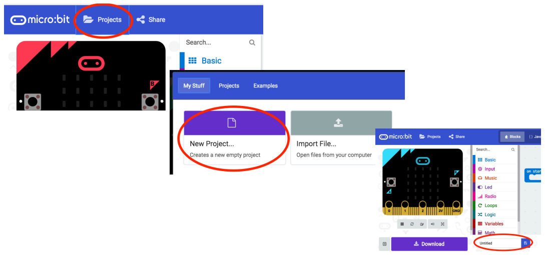
- Broadcasting
- Network Addresses
- Asynchronous clocks / Sync problems

```
radio send number 0
```

```
radio set group 1
```

```
on radio received receivedNumber
```

New Project: Projects > New Project…



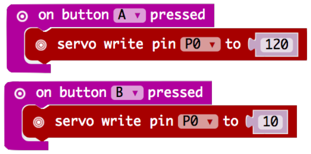
Goody Bag: Hardware

Motor Mayhem

An Intro to Servos

Motor Mayhem

An Intro to Servos



```
on button A pressed
    servo write pin P0 to 120
on button B pressed
    servo write pin P0 to 10
```

Inchworm Insanity

https://makecode.microbit.org/projects/inchworm

Awesome (?) Audio

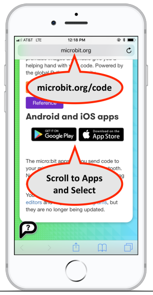
Time Permitting

Concepts

- I/O
- Basic Electric Circuits/Electronics

Break & App Install

Android & iOS


AT&T LTE
12:18 PM
microbit.org
helping hand with code. Powered by
the global
Reference
Android and iOS apps
GET IT ON Google Play
Download on the App Store
The micro:bit apps you send code to
your tooth.
You
editors, but
they are no longer being updated.

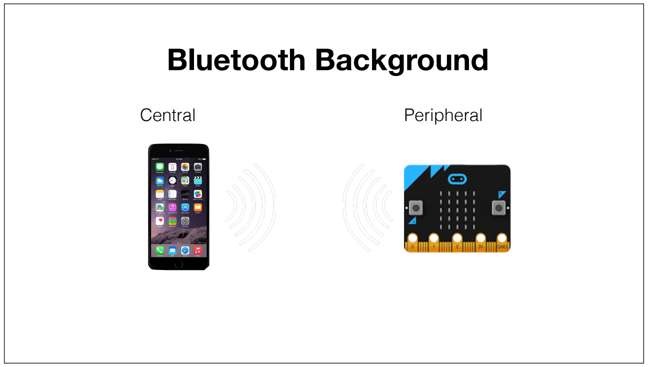
microbit.org/code

Scroll to Apps and Select

Android (optional) Search for & Install Bitty Controller ($1.99)

Bluetooth Background

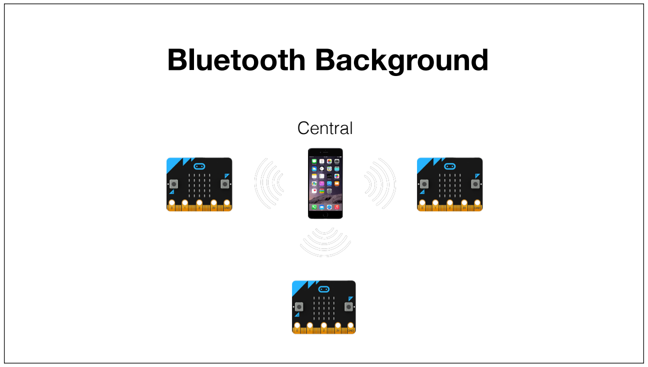
- Uses different protocol than Radio
- Not a group broadcast



Bluetooth Background

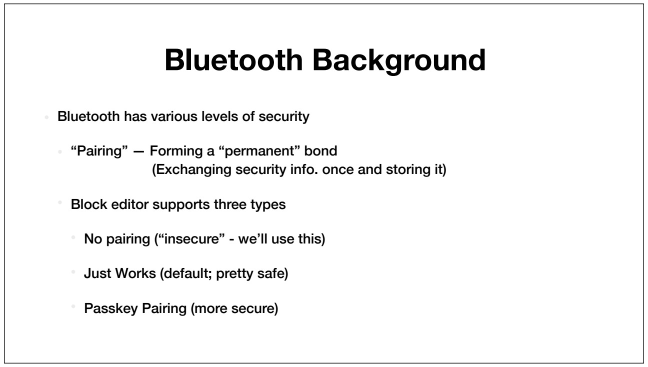
Central

Peripheral



Bluetooth Background

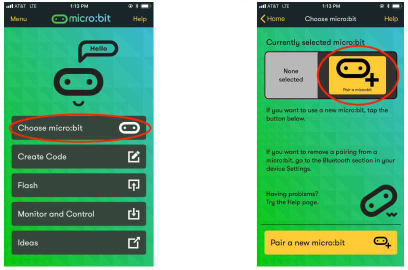
Central



Bluetooth Background

- Bluetooth has various levels of security
  - “Pairing” — Forming a “permanent” bond
    (Exchanging security info. once and storing it)
  - Block editor supports three types
    - No pairing (“insecure” - we’ll use this)
    - Just Works (default; pretty safe)
    - Passkey Pairing (more secure)

Pairing

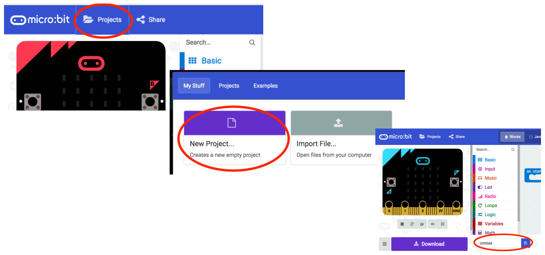


If you want to use a new micro:bit, tap the button below.

If you want to remove a pairing from a micro:bit, go to the Bluetooth section in your device Settings.

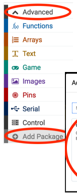
Having problems?
Try the Help page.

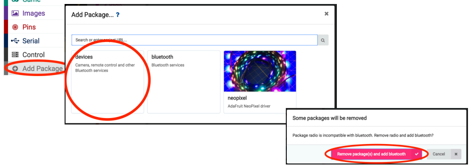
New Project: Projects > New Project...



Add Devices

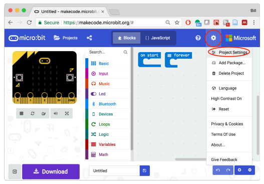
(& remove Radio)

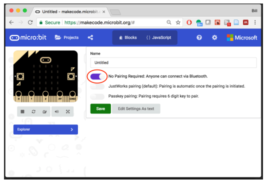



Add Package... ?
Search or enter project URL...
devices
Camera, remote control and other Bluetooth services
bluetooth
Bluetooth services
neopixel
AdaFruit NeoPixel driver
Some packages will be removed
Remove package(s) and add bluetooth
Cancel

Package radio is incompatible with bluetooth. Remove radio and add bluetooth?

Project Settings



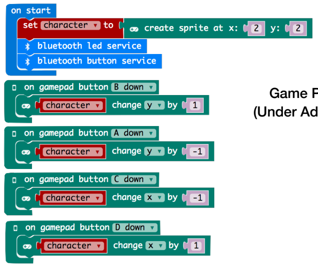


Name: Untitled

- No Pairing Required: Anyone can connect via Bluetooth.
- JustWorks pairing (default): Pairing is automatic once the pairing is initiated.
- Passkey pairing: Pairing requires 6 digit key to pair.

Program

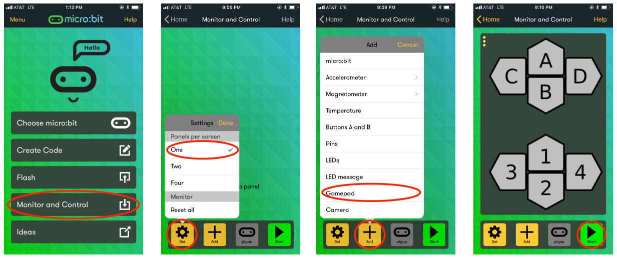
Devices Palette



```
on start
    set character to  create sprite at x: 2 y: 2
    bluetooth led service
    bluetooth button service

on gamepad button B down
    character change y by 1

on gamepad button A down
    character change y by -1

on gamepad button C down
    character change x by -1

on gamepad button D down
    character change x by 1
```

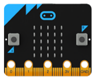
Game Palette
(Under Advanced)

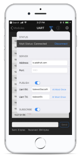
App Configuration

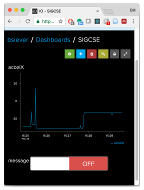


IoT Example

AdaFruit.io





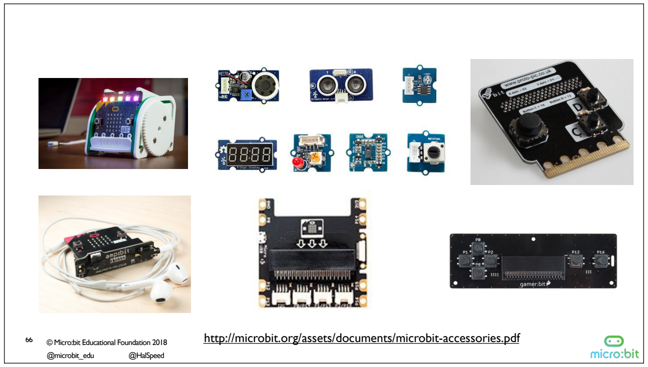


Misc.

- C (C++) / Arduino
- Phone acts as border router
- AdaFruit.io can tie into other services
  - Texts/Notifications (IFTTT), Webhooks, etc.

Additional Hardware

http://microbit.org/assets/documents/microbit-accessories.pdf

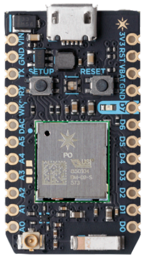


http://microbit.org/assets/documents/microbit-accessories.pdf

Break!

Photon Phun!

- Microcontroller
  - 120MHz ARM Cortex M3
  - 128kB RAM
  - 1MB Flash
  - Real-Time OS
  - 802.11 b/g/n
- Particle's API & Cloud Services



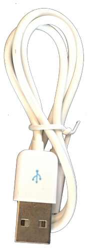
Project Overview

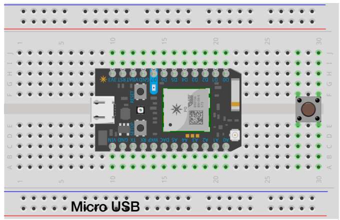
- Blink an LED
  - On-board
  - Circuits: An external LED
- Cloud-Controlled Blink
  - Console Control
- Button & Status

http://particle.io/build

- Login
  - Username: ccsccp@siever.info
  - Password: ccsccp2018

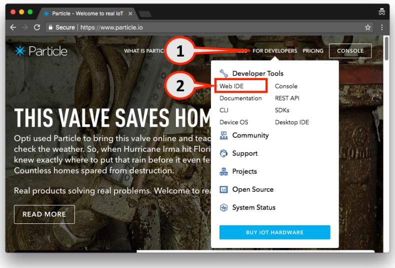
Breadboard, Photon, & USB Power





Micro USB plug

Web IDE

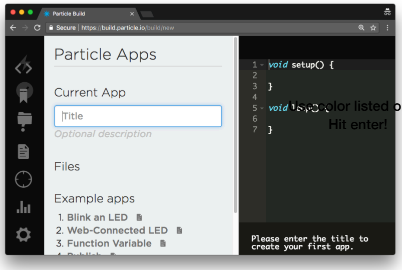


THIS VALVE SAVES HOM

Opti used Particle to bring this valve online and teac
check the weather. So, when Hurricane Irma hit Flori
knew exactly where to put that rain before it even fe
Countless homes spared from destruction.

Real products solving real problems. Welcome to rea

App Name



```
void setup() {

}

void loop() {

}
```

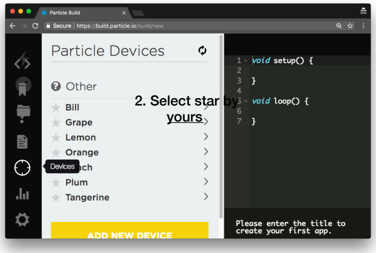
Please enter the title to create your first app.

Use color listed on kit

Hit enter!

Select Your Device

1. Devices

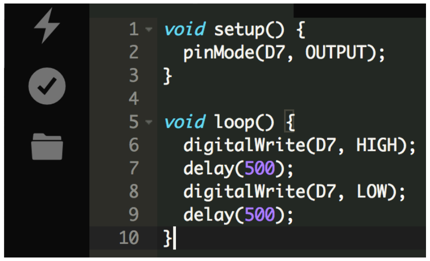


```
void setup() {

}

void loop() {

}
```

Please enter the title to create your first app.

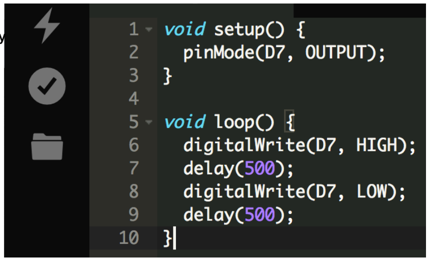
2. Select star by yours

Code



```
void setup() {
  pinMode(D7, OUTPUT);
}

void loop() {
  digitalWrite(D7, HIGH);
  delay(500);
  digitalWrite(D7, LOW);
  delay(500);
}
```

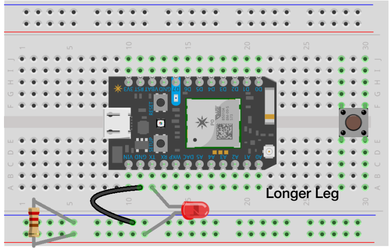
Program / Deploy



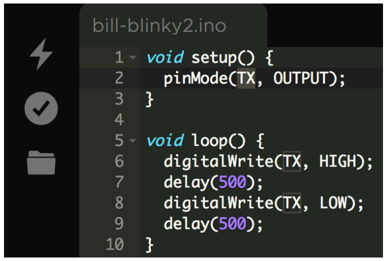
Hit “Flash” to compile/deploy

```
void setup() {
  pinMode(D7, OUTPUT);
}

void loop() {
  digitalWrite(D7, HIGH);
  delay(500);
  digitalWrite(D7, LOW);
  delay(500);
}
```

Wire External LED

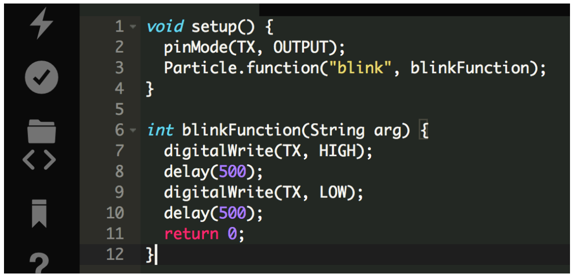


Update Code & Flash



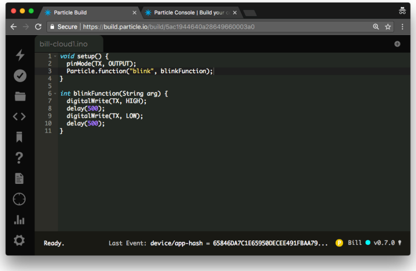
```
void setup() {
  pinMode(TX, OUTPUT);
}

void loop() {
  digitalWrite(TX, HIGH);
  delay(500);
  digitalWrite(TX, LOW);
  delay(500);
}
```

Cloud Control



```
void setup() {
  pinMode(TX, OUTPUT);
  Particle.function("blink", blinkFunction);
}

int blinkFunction(String arg) {
  digitalWrite(TX, HIGH);
  delay(500);
  digitalWrite(TX, LOW);
  delay(500);
  return 0;
}
```

Cloud Console

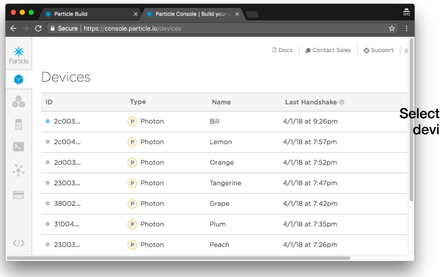

Particle Build
Particle Console | Build your c
Secure | https://build.particle.io/build/5ac1944640a28649660003a0
bill-cloud1.ino

```
void setup() {
  pinMode(TX, OUTPUT);
  Particle.function("blink", blinkFunction);
}

int blinkFunction(String arg) {
  digitalWrite(TX, HIGH);
  delay(500);
  digitalWrite(TX, LOW);
  delay(500);
}
```

```
Ready.        Last Event: device/app-hash = 65846DA7C1E65950DECEE491FBAA79...  Bill  v0.7.0
```

Open Console

Select Device

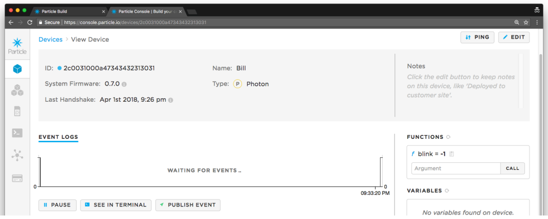

Particle Build
Particle Console | Build your c
Secure | https://console.particle.io/devices
Docs
Contact Sales
Support
Particle

Devices

ID	Type	Name	Last Handshake
● 2c003...	P Photon	Bill	4/1/18 at 9:26pm
● 2c004...	P Photon	Lemon	4/1/18 at 7:57pm
● 2d003...	P Photon	Orange	4/1/18 at 7:52pm
● 23003...	P Photon	Tangerine	4/1/18 at 7:47pm
● 38002...	P Photon	Grape	4/1/18 at 7:42pm
● 31004...	P Photon	Plum	4/1/18 at 7:35pm
● 23003...	P Photon	Peach	4/1/18 at 7:26pm

Select your device

Call Function



Devices > View Device

ID: ● 2c0031000a47343432313031

System Firmware: 0.7.0

Last Handshake: Apr 1st 2018, 9:26 pm

Name: Bill

Type: P Photon

Notes

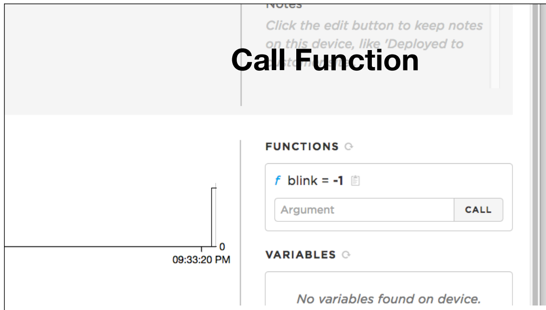
Click the edit button to keep notes on this device, like 'Deployed to customer site'.

f blink = -1

Argument

No variables found on device.

Call Function



Notes

Click the edit button to keep notes on this device, like 'Deployed to

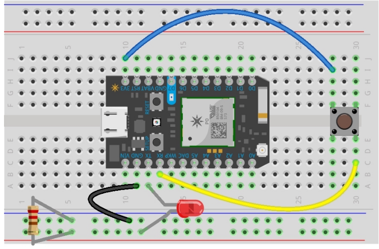
f blink = -1

Argument

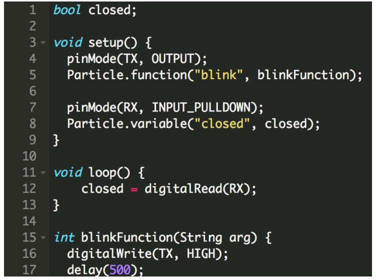
No variables found on device.

Hit “Call” to call it

Add a Button

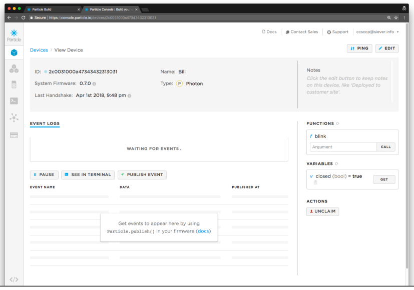


Add a Cloud Variable



```
bool closed;

void setup() {
  pinMode(TX, OUTPUT);
  Particle.function("blink", blinkFunction);

  pinMode(RX, INPUT_PULLDOWN);
  Particle.variable("closed", closed);
}

void loop() {
    closed = digitalRead(RX);
}

int blinkFunction(String arg) {
  digitalWrite(TX, HIGH);
  delay(500);
```

Reload Console



ID: 2c0031000a47343432313031

Name: Bill

System Firmware: 0.7.0

Type: P Photon

Last Handshake: Apr 1st 2018, 9:48 pm

Notes

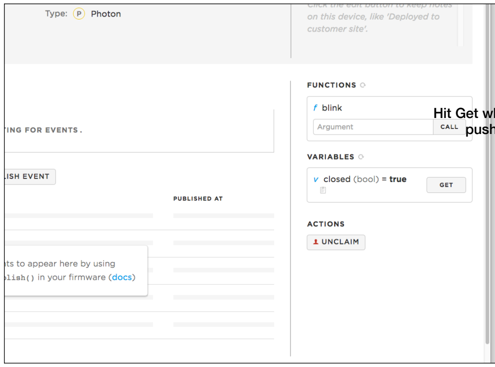
Click the edit button to keep notes on this device, like 'Deployed to customer site'.

WAITING FOR EVENTS.

Get events to appear here by using `Particle.publish()` in your firmware (docs)

f blink

v closed (bool) = **true**



Type: Photon

Click the edit button to keep notes on this device, like 'Deployed to customer site'.

ING FOR EVENTS.

ts to appear here by using
lish() in your firmware (docs)

FUNCTIONS

f blink

VARIABLES

v closed (bool) = true

New!
Hit Get while pushing/not pushing button

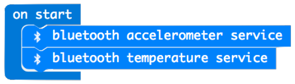
An “App” for that: A quick tour

A “real” IoT application

Questions / Discussion

Apps for Data Logging: bittydatalogger

Program



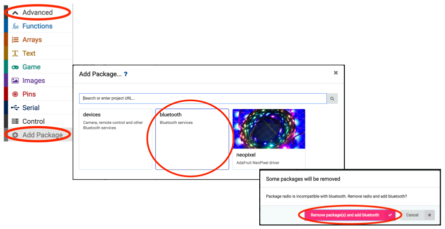
```
on start
  bluetooth accelerometer service
  bluetooth temperature service
```

Concepts

- Data Formats (CSV vs. JSON)
- Data Analysis

Remove Add Bluetooth

(& remove Radio)



Camera, remote control and other Bluetooth services

Bluetooth services

AdaFruit NeoPixel driver

Some packages will be removed

Package radio is incompatible with bluetooth. Remove radio and add bluetooth?