2017 MASTERs Conference

Getting Started with Johnny Five – The JavaScript Robotics and IoT Platform

MICROCHIP

Class Objectives

When you walk out of this class you will be able to…

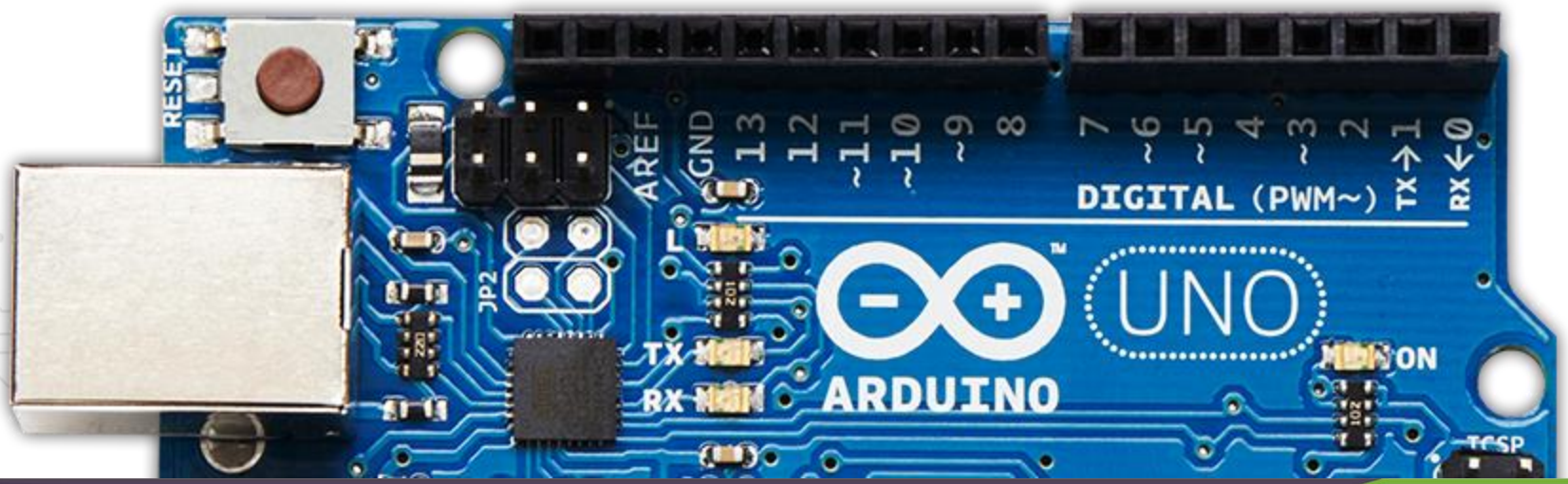
- **Program Arduino using Arduino Create and control using JohnnyFive**
- **Connect Arduino to the internet and control it remotely**
- **Publish sensor data to the web and visualize them using charts**

Agenda

- Intro to Johnny Five and Firmata
- Lab 1 – Hello World with Johnny Five
- IoT Concepts
- Lab 2 – Hello World for IoT
- Lab 3 – Sensor Data Visualization
- Summary

Arduino

- **Open-source prototyping platform based on easy-to-use hardware and software**
- **Write code and upload in minutes**



Firmata Protocol

- **Communicating with microcontrollers from software on a computer (or smartphone/tablet)**

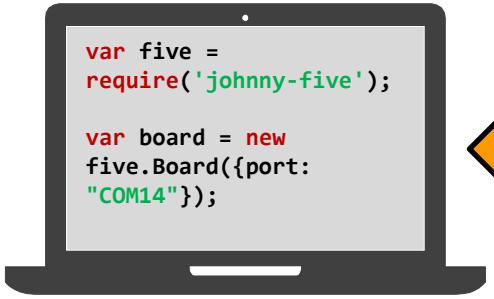
- **Methods of implementation**
  - Firmware of any microcontroller architecture
  - Any computer software package

Methods of Implementation of Firmata Protocol

- **Firmware of any microcontroller architecture**
  - E.g. StandardFirmata for Arduino and ChipKit platforms
- **Any computer software package**
  - Available in forms of multiple client libraries in different languages
  - Johnny Five is the JavaScript implementation of Firmata

Firmata Implementation

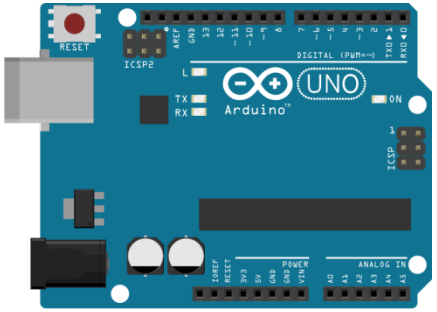
The Client runs a JavaScript program using Johnny Five



Client

Serial Communication

The Device runs a program using Firmata protocol



Device

What is Johnny Five

- Johnny Five is the JavaScript Robotics & IoT Platform
- Node.js based software framework
- Client Implementation of Firmata Protocol

Node.js

- **Platform for building fast and scalable network applications easily**
- **Uses an event-driven, non-blocking I/O model**
- **Lightweight and efficient**
  - Perfect for data-intensive real-time applications that run across distributed devices

But why JavaScript?!

Why not Embedded C?

- **Designed for IoT applications**
  - Applications easily connect to various web and cloud services using JavaScript
- **Allows software/web developers to program IoT devices without learning a new language**
  - Most web developers are already using JavaScript for their entire software stack

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Lab 1

Hello World with Johnny Five

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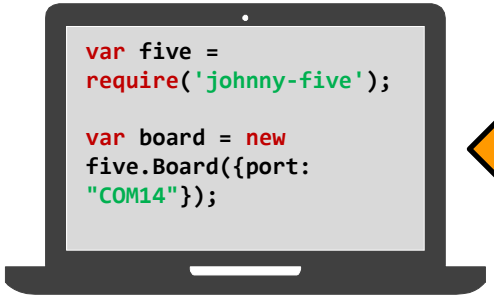
Lab 1 Objectives

- **Create a Hello World application using Johnny Five**
- **Blink an LED on Arduino Uno board while being controlled by Client**

Lab 1 Objectives

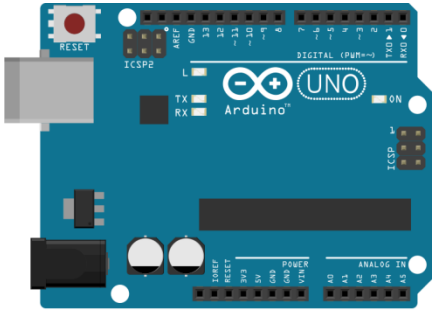
The Client runs a JavaScript program using Johnny Five



Client

Serial Communication

The Device runs a program using Firmata protocol



Device

Lab 1 Workflow

- System Setup
- Burn Firmata onto Arduino board
- Write client-side code using Johnny Five
- Execute program using Node

System Setup

- **Install Node.js**

  https://nodejs.org/

- **Install Johnny Five via NPM**

  ```
  npm install johnny-five
  ```

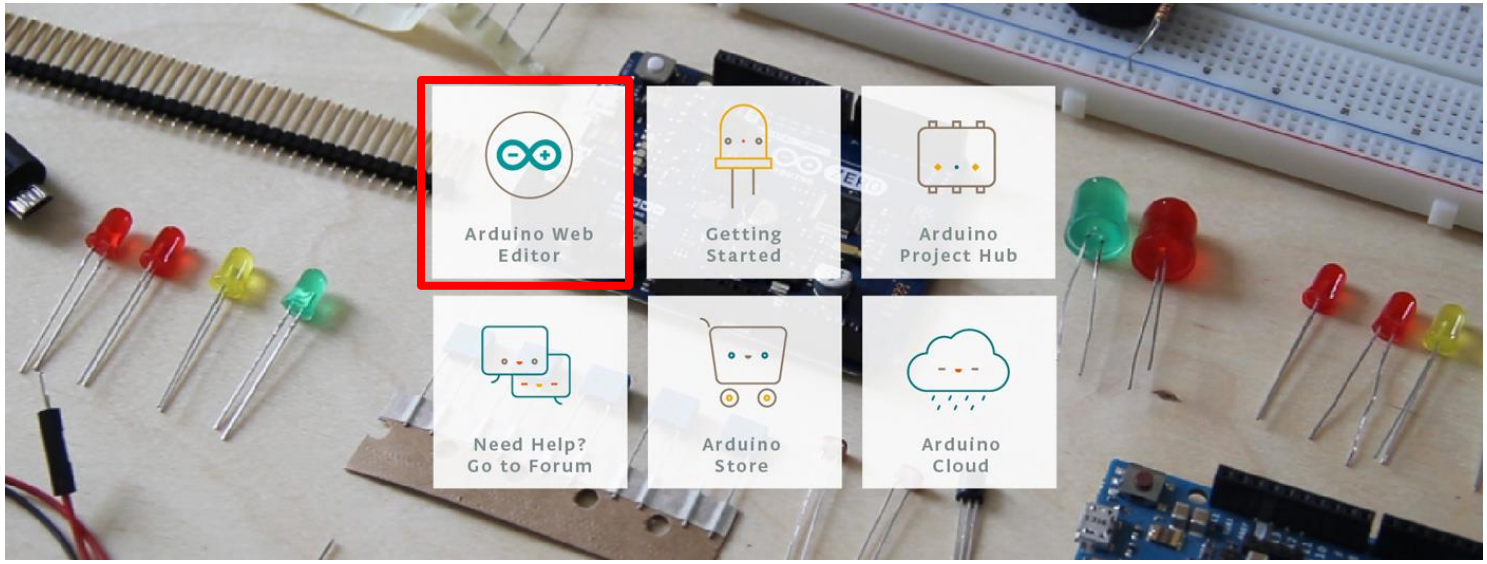
- **Install PubNub via NPM**

  ```
  npm install pubnub
  ```

Arduino Create

- **Integrated online platform to write code, access content, configure boards, and share projects**

https://create.arduino.cc/



Log into Arduino Web Editor

Username

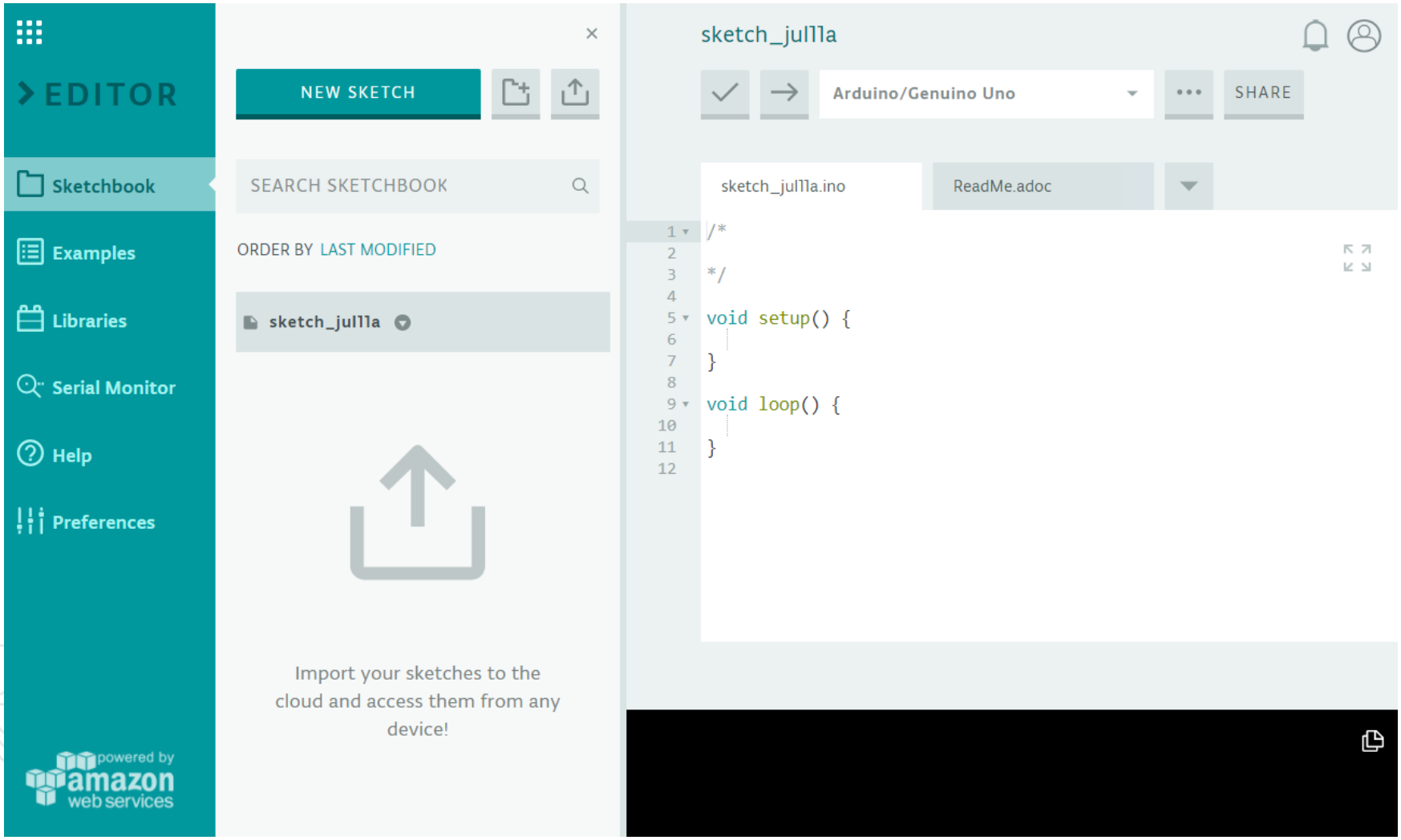
`microchiptestuser1`

Password

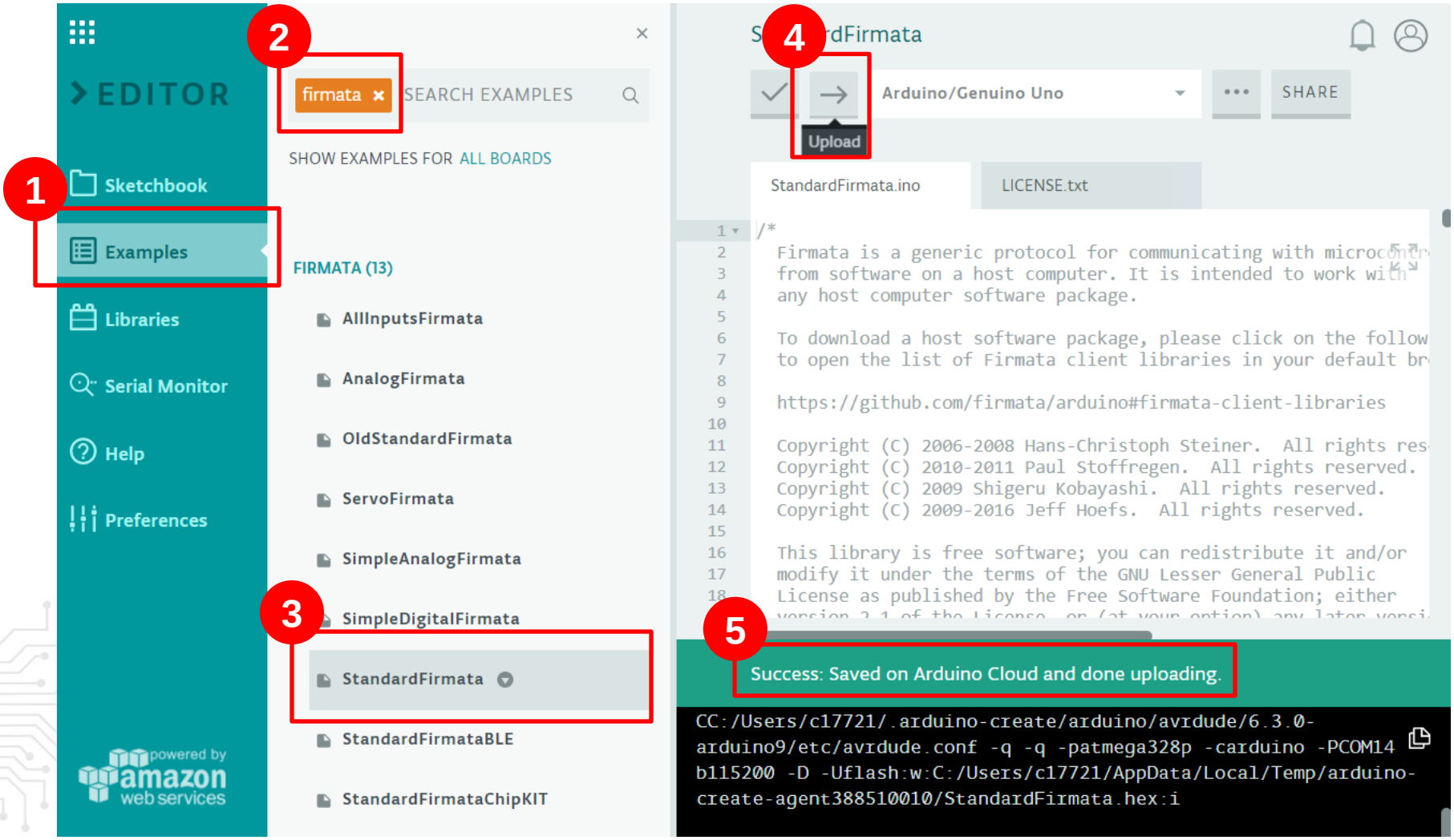
`masters2017`

Install Arduino Plugin

Arduino Web Editor



Upload Firmata onto Arduino



Blinking LED with Johnny Five

- **Create a file `blink.js` with this code:**

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

board.on('ready', function() {
  var led = new five.Led(13); // pin 13
  led.blink(500);             // 500ms interval
});
```

- **Run:**

```
$ sudo node blink.js
```

Lab 1 Summary

- Learned to use Arduino Web Editor
- Loaded Firmata onto Arduino
- Executed code using Johnny Five using Node

Pop Quiz 1

- **What is the JavaScript client implementation of Firmata called?**
  - (a) Node.js
  - (b) Johnny Five
  - (c) Arduino Uno
  - (d) Arduino Create

Pop Quiz 1

- **What is the JavaScript client implementation of Firmata called?**
  - (a) Node.js
  - *(b) Johnny Five* ☺
  - (c) Arduino Uno
  - (d) Arduino Create

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IoT Concepts

Connecting Arduino to the World using Johnny Five

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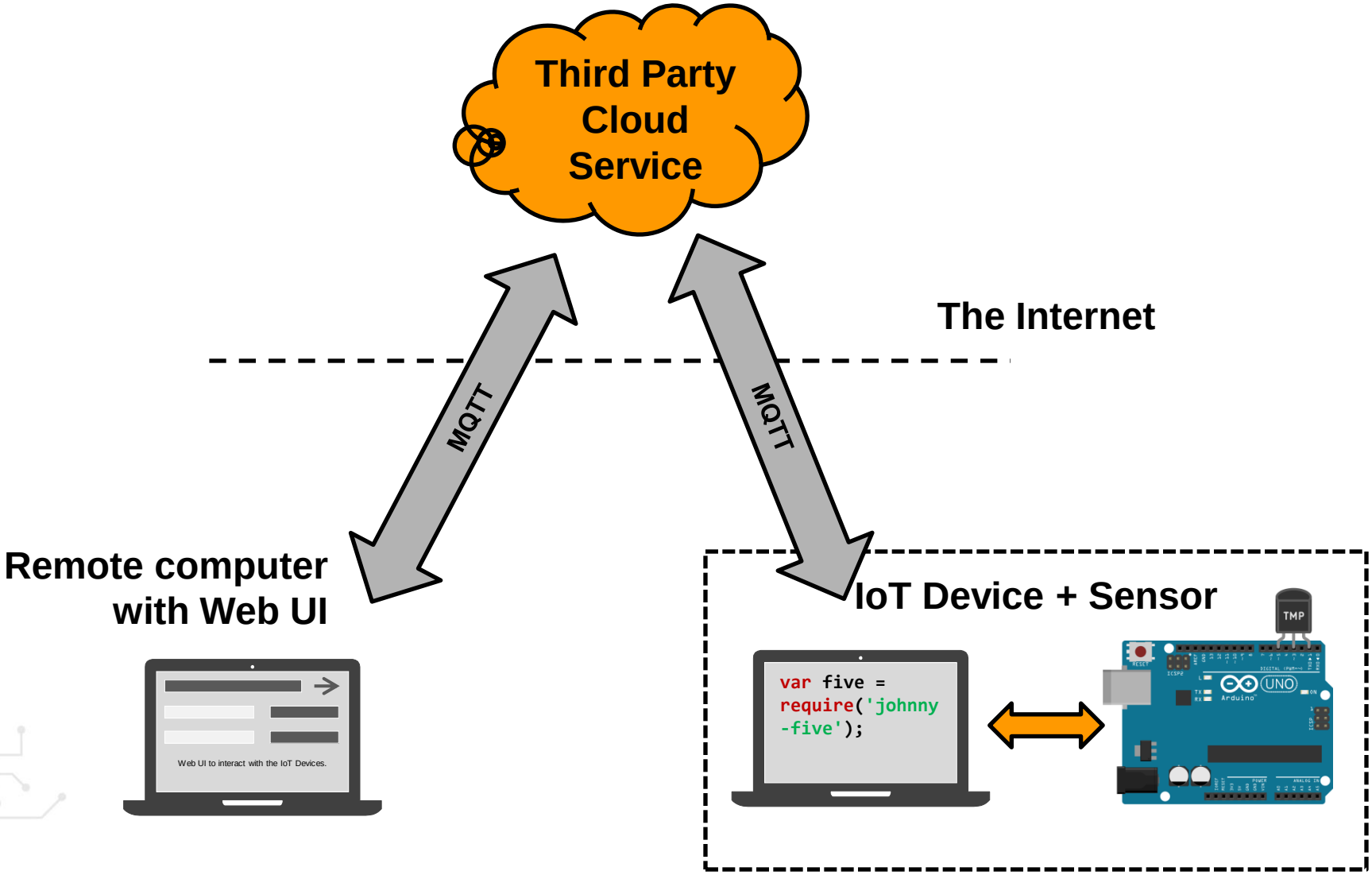
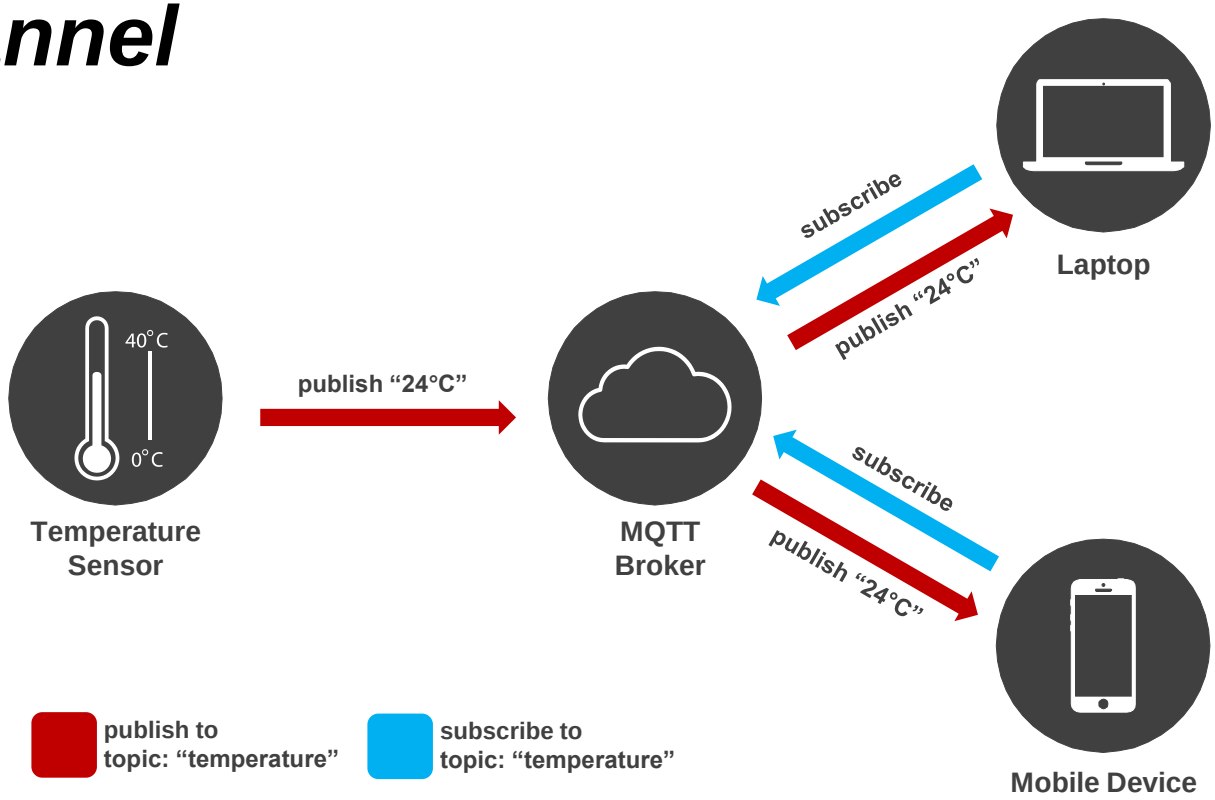
Basic IoT Setup



Pub/Sub Model

- ***Clients*** **decoupled via a** ***Broker***
- **Clients** ***publish*** **data or** ***subscribe*** **to a** ***topic/channel***



Browser-side Code

JS

HTML

CSS

Makes the items functional

Creates the structure of a web page

Makes the items look beautiful

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Lab 2

The Hello World of IoT

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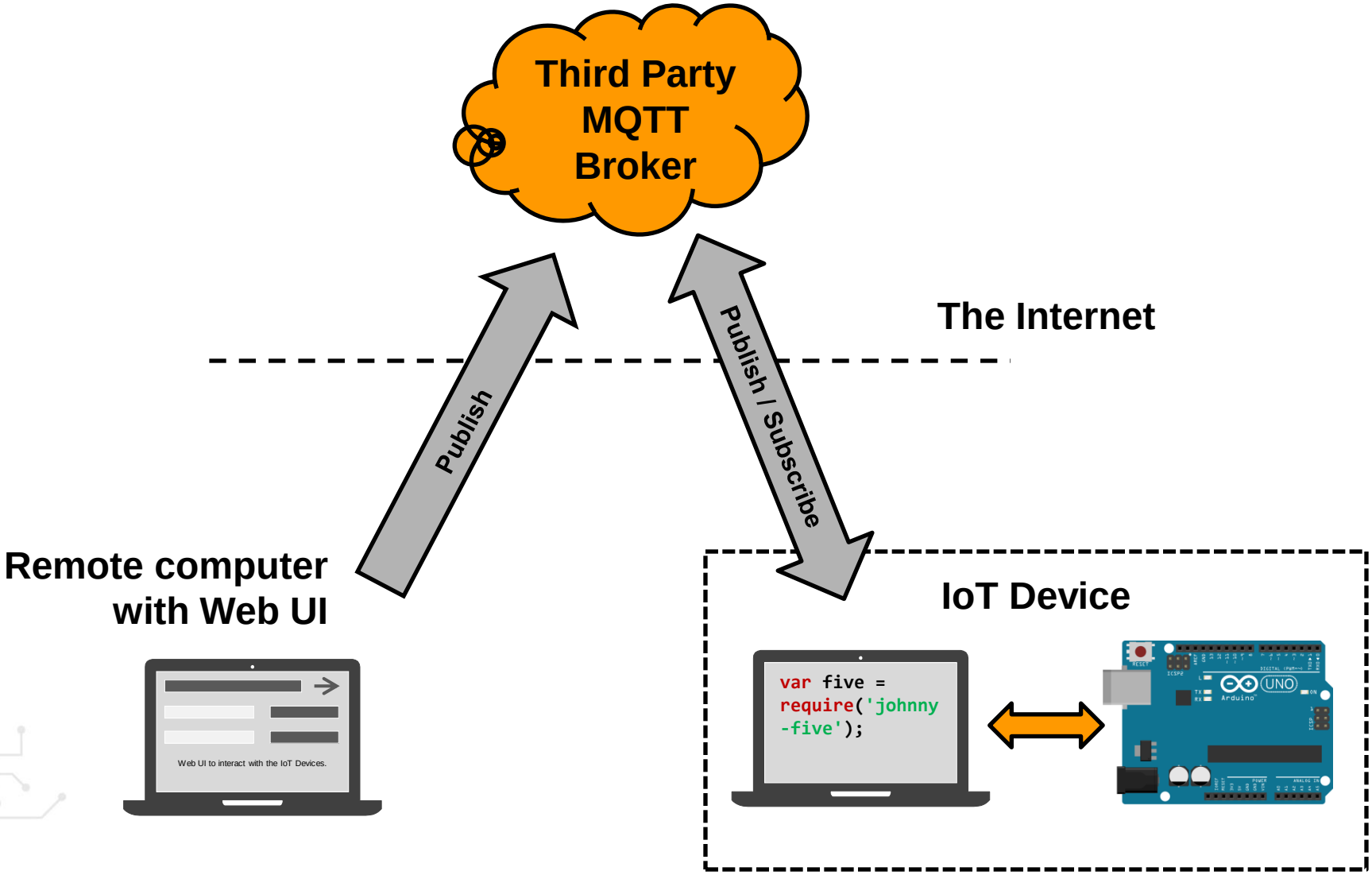
Lab 2 Objectives

- Create a Hello World application using IoT concepts
- Blink an LED on Arduino Uno board being controlled by a remote Client over the web

Lab 2 Objectives



MQTT Broker: PubNub

- **PubNub is a Data Stream Network for developers to build realtime apps**
- **Over 70 SDKs for mobile, web, desktop and server**
- **Get your free keysets from*:**

  https://www.pubnub.com/

*** For this class, use your assigned keysets from `pubnub-keysets.txt` file.**

Lab 2 // Part A

BROWSER-SIDE JAVASCRIPT

JavaScript SDK Basics

- **Install from CDN**

```
<script src =
"https://cdn.pubnub.com/sdk/javascript/pubnub.4
.8.0.js"></script>
```

- **Node.js**

```
$ npm install pubnub
```

Initialization

- **new creates an instance of the PubNub object for invoking PubNub operations**

```
var pubnub = new PubNub({
  subscribeKey: "sub-c-801ccfbc-...",
  publishKey: "pub-c-cfd2c879-...",
  ...
});
```

Publish

- **publish() is used to send messages to all subscribers of a channel**

```
pubnub.publish({
   channel: "temperature",
   message: {
         val: 22.5,
         unit: "celsius"
   }
});
```

JavaScript Object

Subscribe

- `subscribe()` causes the client to create an open TCP socket and begin listening for messages on a channel

```
pubnub.subscribe({
  channels: ["temperature", ... ],
  ...
});
```

Add Listener

- `addListener()` receives all the messages published on a channel

```
pubnub.addListener({
  message: function(m){ console.log(m) },
  error: function(e){ console.log(e) },
  ...
});
```

Browser-side Code

HTML

Creates the structure of a web page

JS

Makes the items functional

CSS

Makes the items look beautiful

Browser-side HTML

- Create a file **blink-remote-client.html** with:

```
<html><head>
  <title>Remote LED Blink</title>
  <script src="https://cdn.pubnub..."></script>
  <!-- Insert CSS styling here -->
</head>
<body>
  <h1>Prototyping IoT Demo UI</h1>
  <button class="on">Blink LED</button>
  <!– Insert Javascript code here -->
</body></html>
```

Browser-side CSS

- **Insert CSS in `blink-remote-client.html`:**

```
<!-- Insert CSS styling here -->

<style type='text/css'>
  button {
    font-size: 2em;
    padding: 10px 20px;
  }
</style>
```

Browser-side JS

- **Insert JS:**

```
<!-- Insert Javascript code here -->
<script type='text/javascript'>
  var pubnub = new PubNub({
      subscribeKey: "sub-c-801ccfbc-...",
      publishKey: "pub-c-cfd2c879-..." });
  var channel = "led";
  var button =
      document.querySelector("button.on");
  var blinkState = true;
  // Add button event listener here
</script>
```

Browser-side JS

- **Insert Listener:**

```
button.addEventListener("click", function(e){
    pubnub.publish({
        channel: channel,
        message: { blink: blinkState }},
    function(m) {
        console.log(m);
        blinkState = !blinkState;
        button.textContent = blinkState ?
                "Blink LED" : "Stop LED";
    });
});
```

Code Deployed

- **Code deployed at:**
  - https://codepen.io/maxmiaggi/pen/jmdyGX
  - https://maxmiaggi.github.io/blink-remote-client.html

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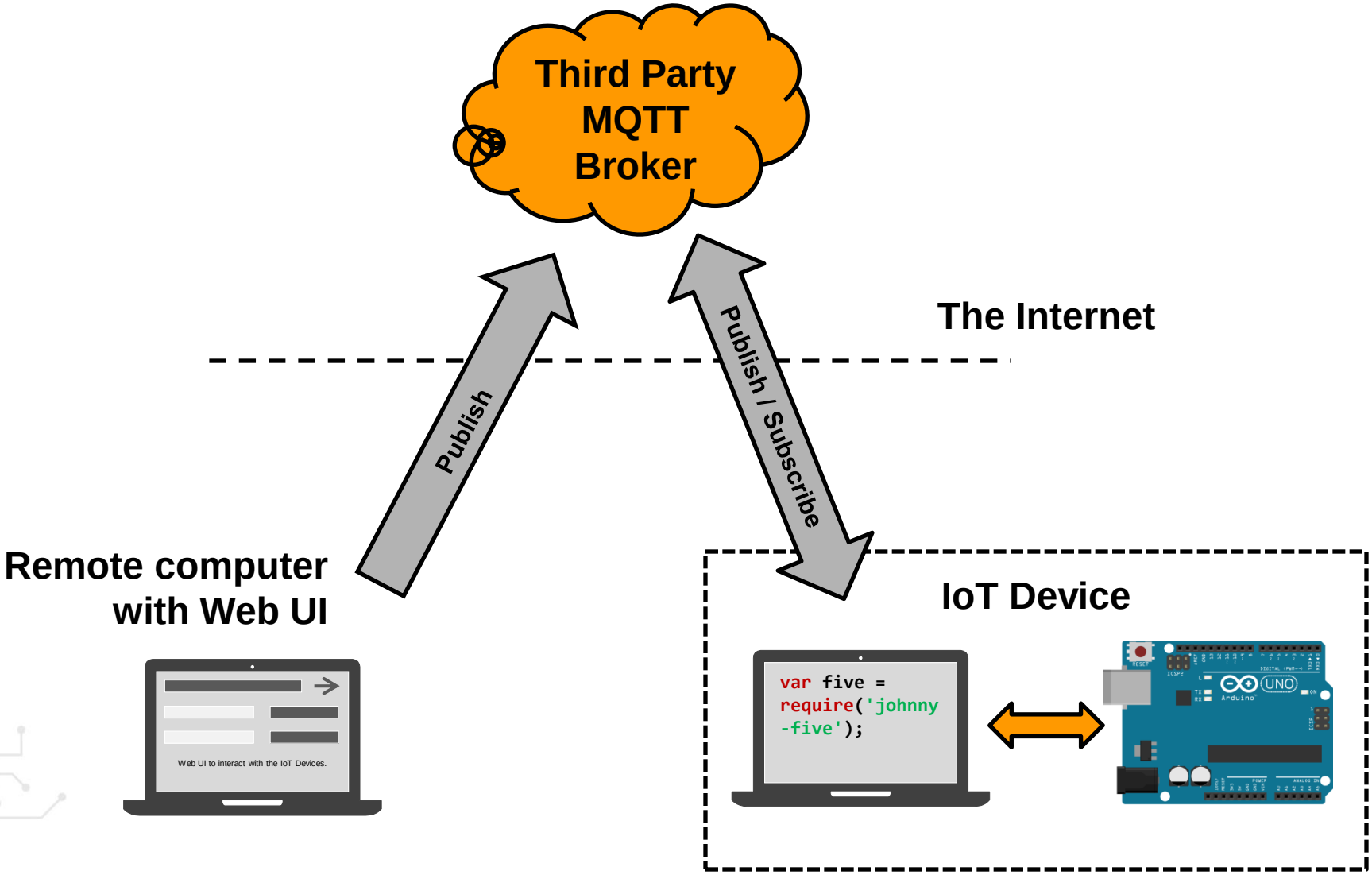
Lab 2 // Part B

SERVER-SIDE NODE.JS

Lab 2 Objectives



Server-side NodeJS

- **Add following in `blink-remote.js`:**

```
var channel = 'led';
board.on('ready', function() {
  var led = new five.Led(13); // pin 13
  pubnub.addListener({
    ...
  });
  pubnub.subscribe({
    channels: [channel],
  });
});
```

Server-side NodeJS

- **Add Listener in `blink-remote.js`:**

```
pubnub.addListener({
    message: function(m) {
      if(m.message.blink == true) {
        led.blink(500);
      } else {
        led.stop();
        led.off();
      }
    }
  });
```

Lab 2 Summary

- **Created a Hello World application using IoT concepts**
- **Controlled an LED on Arduino Uno board by a remote Client over the web**

Pop Quiz 2

- **Which of the following is not absolutely required for a web page to be functional?**
  - (a) HTML
  - (b) CSS
  - (c) JavaScript
  - (d) All of them are needed

Pop Quiz 2

- **Which of the following is not absolutely required for a web page to be functional?**
  - (a) HTML
  - *(b)* *CSS* ☺
  - (c) JavaScript
  - (d) All of them are needed

Pop Quiz 3

- **In the Pub/Sub Model, clients can subscribe to any number of channels at the same time.**
  - (a) True
  - (b) False

Pop Quiz 3

- **In the Pub/Sub Model, clients can subscribe to any number of channels at the same time.**
  - (a) *True* ☺
  - (b) False

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Lab 3

IoT: Sensor Data Visualizations

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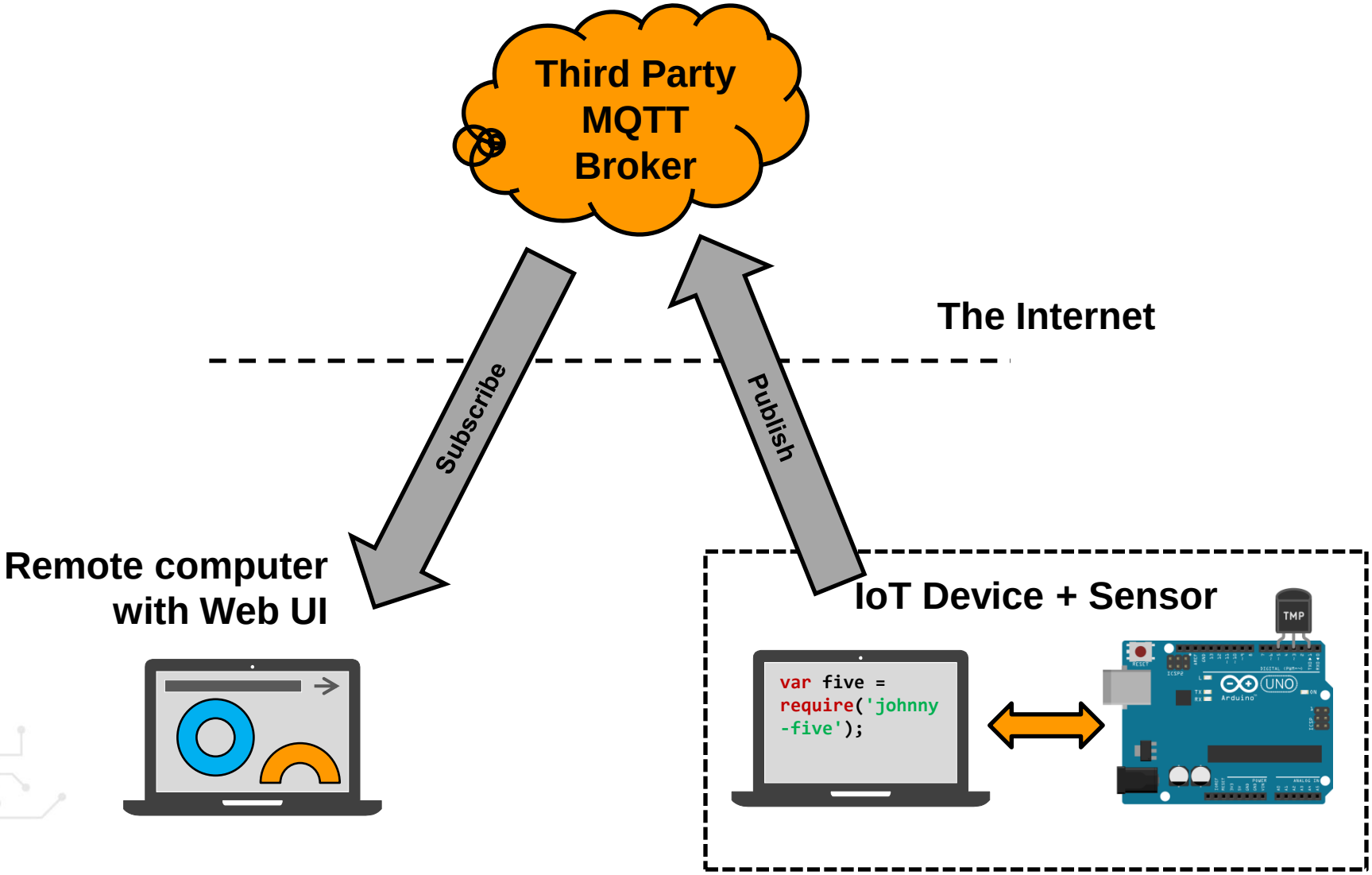
Lab 3 Objectives

- **Read sensor data from Arduino and publish to web**
- **Subscribe to the sensor data via a web page and create a visual using charts**

Lab 3 Objectives



What is EON

- Real-time visualization of data
- Open-source JavaScript Framework for Charting & Mapping
- Easy to get real-time data from PubNub channels
- Easy to use the data to plot graphs or maps

Plotting a Basic Chart

1. **Publish data to PubNub**
2. **Receive the data & display a chart**
   - Basic chart
   - Basic chart + history
   - Multiple graphs from multiple data
   - Customize the chart

Lab 3 // Part A

SERVER-SIDE NODE.JS

Publishing Data

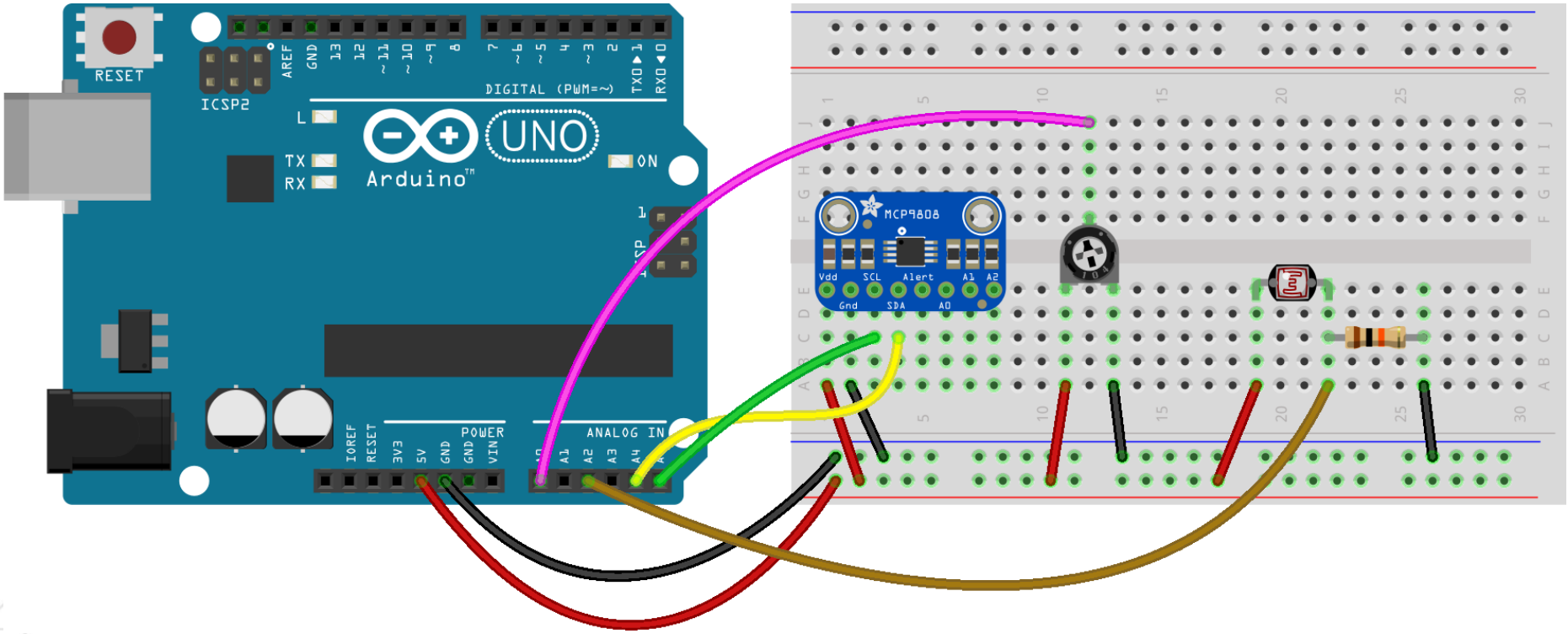
- **Initialize**

```
var PubNub = require('pubnub')();
var pubnub = new PubNub({
  subscribeKey: "sub-c-801ccfbc-...",
  publishKey: "pub-c-cfd2c879-...",
});
```

- **Publish some data**

```
pubnub.publish({
  channel: "my-data",
  message: { eon: {"humidity": 90} }
});
```

Circuit Diagram



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Lab 3 // Part B

BROWSER-SIDE JAVASCRIPT

Plotting a Line Graph

```
<html>
   <head>
         <script type="text/javascript"
src="http://pubnub.github.io/eon..."></script>
         <link type="text/css" rel="stylesheet"
href="http://pubnub.github.io/eon..." />
   </head>

   <body>
         <div id="chart"></div>
         <!-- Insert EON JavaScript here -->
   </body>
</html>
```

EON Browser-side JavaScript

```
<script type="text/javascript">
   var pubnub = new PubNub({
         subscribeKey : "sub-c-486be1d0-..."
   });

   eon.chart({
         channels    : ["random1"],
         generate    : { bindto: '#chart' },
         pubnub      : pubnub
   });

</script>
```

Using PubNub History API

```
eon.chart({
        channels    : ["random1"],
        generate    : { bindto: '#chart' },
        history     : true,
        pubnub      : pubnub
});
```

Publishing Multiple (Fake) Data

```
var data = { eon: {
        'value0' : Math.floor(Math.random()*99),
        'value1' : Math.floor(Math.random()*99),
        'value2' : Math.floor(Math.random()*99),
        'value3' : Math.floor(Math.random()*99),
        'value4' : Math.floor(Math.random()*99)
   }
}
pubnub.publish({
   channels  : ['random5'],
   message   : data,
});
```

Plotting Multiple Graphs

```
var pubnub = new PubNub({
        subscribeKey : "sub-c-486be1d0-..."
  });

  eon.chart({
        channels    : ["random5"],
        generate    : { bindto: '#chart' },
        pubnub      : pubnub
  });
```

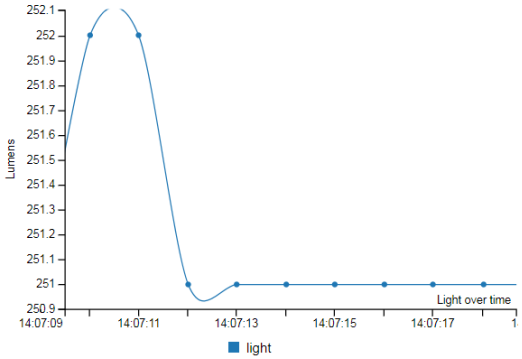
Customizing & Styling Data

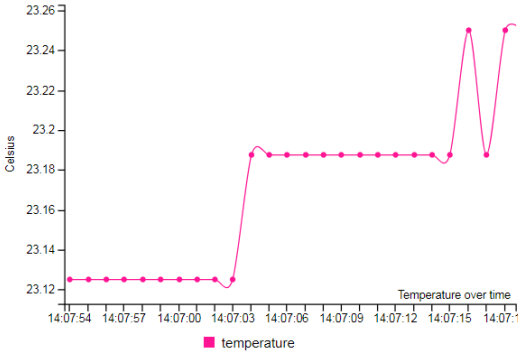
```
eon.chart({
   channels    : ["random1"],
   generate    : {
         bindto: '#chart',
         axis: { x: {
               type: 'timeseries',
               tick: { format: '%H:%m:%S' } },
         y: {
               label: { text: 'Temperature',
                        position: 'outer-middle'}
         } },
   }, ...
```

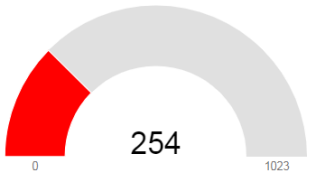
Code Deployed

- **Code deployed at:**
  - https://codepen.io/maxmiaggi/pen/bRZKYv
  - https://maxmiaggi.github.io/lab3-visuals.html

Sensor Data from Arduino







Lab 3 Summary

- **Read sensor data from Arduino and publish to web**

- **Subscribed to the sensor data via a web page and created a visual using charts**

Pop Quiz 4

- **In order to stream data in real-time and plot charts, what should a client be doing?**
  - (a) Publish to the channel(s)
  - (b) Subscribe to the channel(s)
  - (c) Both, publish and subscribe to the channel(s)
  - (d) Do nothing

Pop Quiz 4

- **In order to stream data in real-time and plot charts, what should a client be doing?**
  - (a) Publish to the channel(s)
  - *(b) Subscribe to the channel(s)* ☺
  - (c) Both, publish and subscribe to the channel(s)
  - (d) Do nothing

Summary

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