Capstone Walkthrough

Michael Montanaro

Introduction

Health

Rock Climbing

Exercise

Concussion

Injuries

Meditation

Kinesiology

Academics

Belmont Hill School

Summa Cum Laude

Northeastern University

Computer Engineering

NewStore, Inc.

Athletics

Black Knights Futsal Club

East Coast Wizards

HS Track and Field

HS Soccer

Northeastern Men's Soccer

Pick-Up Sports

ECE Capstone

Develop a solar powered e-mobility charging station that provides user control via a phone and desktop application. The system allows charging stations to be strategically, and conveniently placed. The physical device will be an off-grid application whereas a scaled up, on-grid version of the station will be simulated via Simulink.

Problem

Toggleable Voltage Output

Energy Conservation

Safety

Voltage Regulation

Unsecured Authentication System

Remote authentication

User tracking

Port-specific authentication

Multi-Platform Target

Mobile and Web Application

User barrier to entry

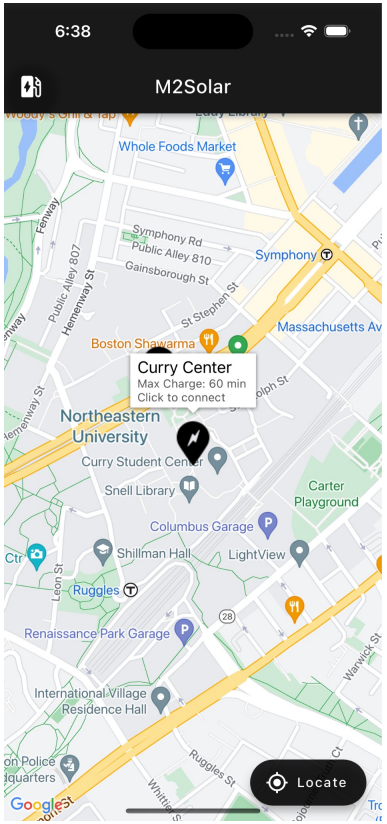
Scalability

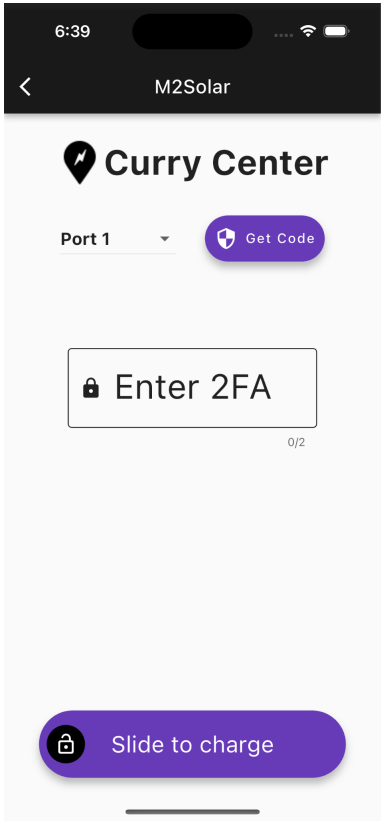
Development Time

< 3-month timeline

One full-stack developer

Multiple deliverables





Solution

Secure Multi-Port 2FA System

Local two-factor authentication code ensures user proximity for connecting to a specified port on the nearby station.

Flutter Cross-Platform Development

Seamlessly develop for a multitude of platforms using a rich UI library and the “Hot Reload” feature

Pulse Width Modulation

Sinusoidal PWM for efficient analog output and regulation to a specified port on the station.

Workflow and Preparation

Designated knowledge acquisition and design phases for thorough timeline predictions.

Flutter Development

Benefits

Hot Reloads

Extensive UI library

Cross-Platform

"Ahead of Time" compiler

Environment

iPhone 17

iPhone 13 mini

Google Pixel

Chrome Browser

Speed Bumps

Deprecated documentation

Async function updates page

Managing MQTT connections

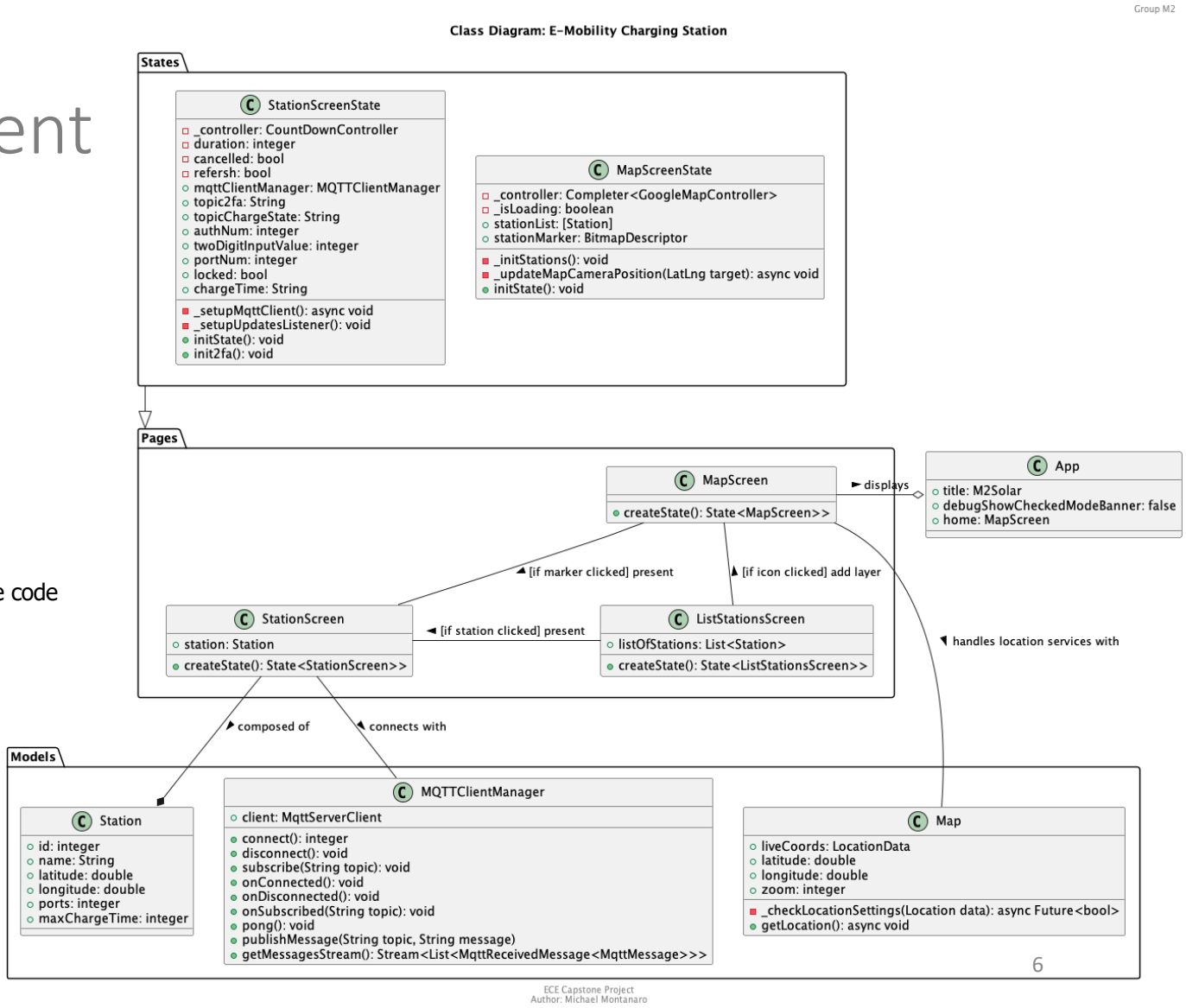
Local staging permissions

Thoughts

Off-putting boilerplate code

Rapid prototyping

High quality libraries



ESP32 Software Development

sPWM

Software-Based Pulse Width Modulation

LED Brightness Testing

Sample indexing to handle zero crossings

Wave generation controlled by MQTT trigger

2FA

Port control linked to unique topics

Authentication State management

Charge State management

Seven-Segment display generated with separate ESP32

MQTT

Low-Power Messaging Protocol

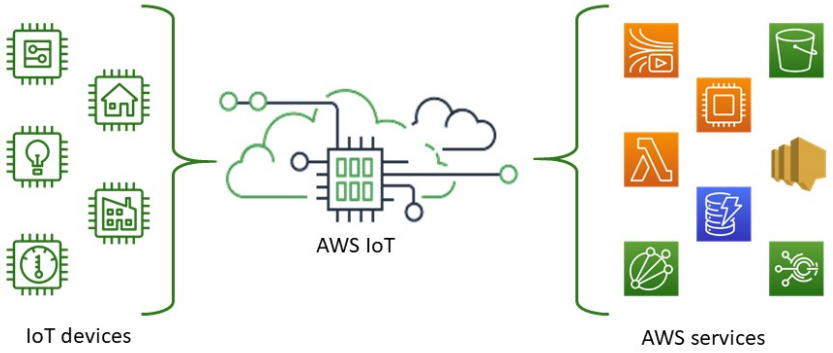
Topic structure to manage ports

Widely available libraries

Real-time updates to sPWM program environment

MQTT Messaging Protocol

AWS IoT Core



AWS EC2 with mosquitto

Rapid development and deployment

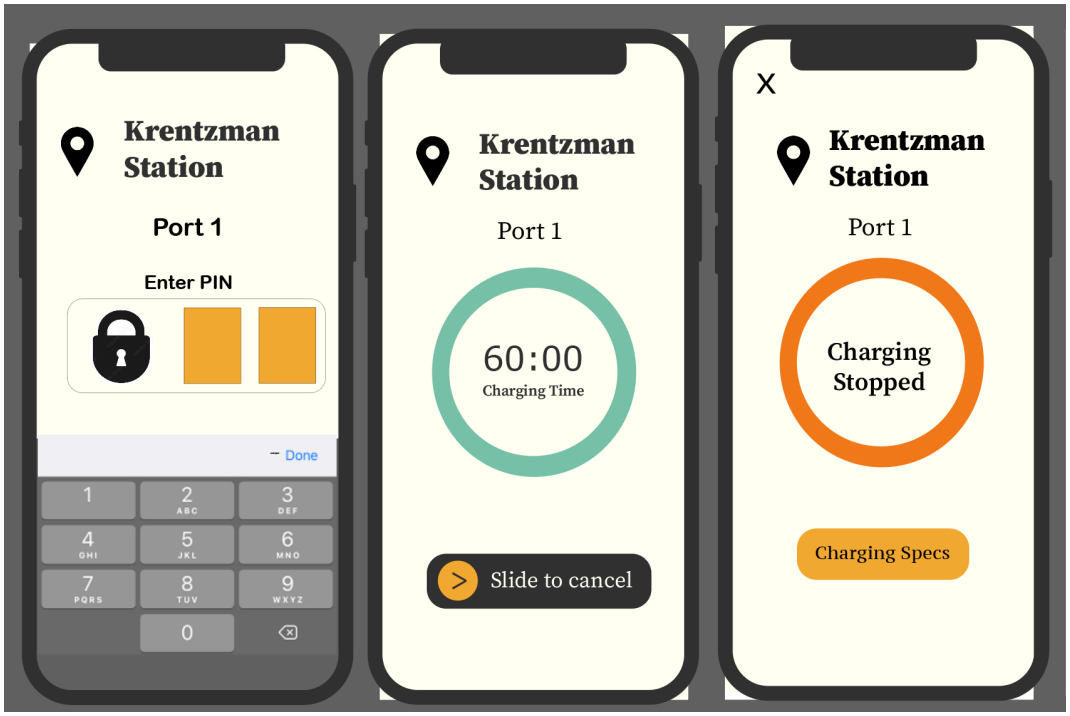
Economical (Free Tier)

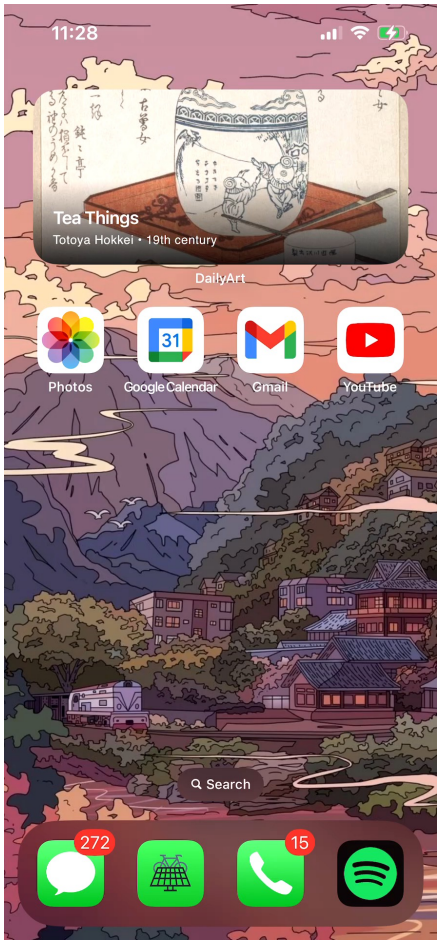
Locked EC2 instance with certificate given to one device

User authentication required for subscribing and publishing

Broker port-forwarded from Docker instance

Final Design and Product





Takeaways

Project Design Phase

Adaptability

Short term deliverables for long term goals

Cross Expertise Communication

General Dynamics: Applied Physical Sciences

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