



T-MOBILE PROGRAMMABLE NARROWBAND IOT BUTTON

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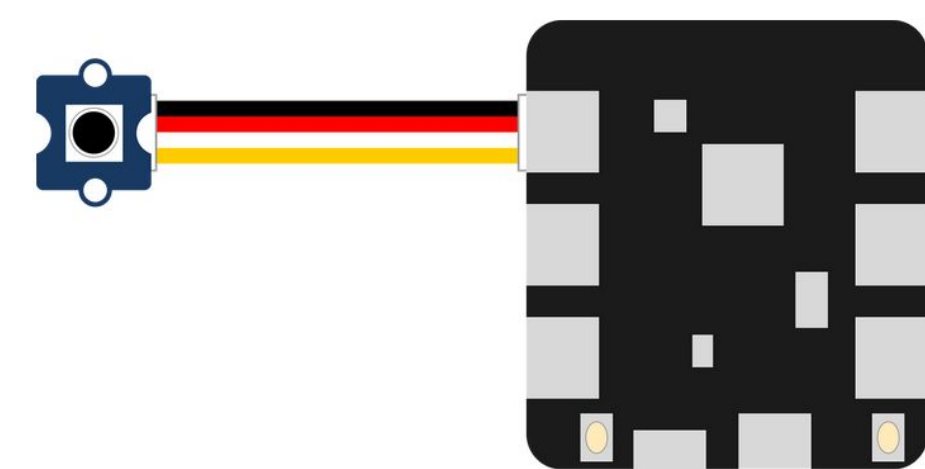


The NB IoT Button Motivation

- Lots of time and resources are spent to achieve customized functionality on NB-IoT (Narrowband Internet of Things) devices.
- Creating a single, customizable device would essentially eliminate the development process and give the user great flexibility.
- This project aims at creating an end-to-end NB-IoT device which communicates over T-Mobile's NarrowBand network.
- Deliverables include a frontend web application, a backend for data storage, an IoT portion, and interconnections that execute automated functions.

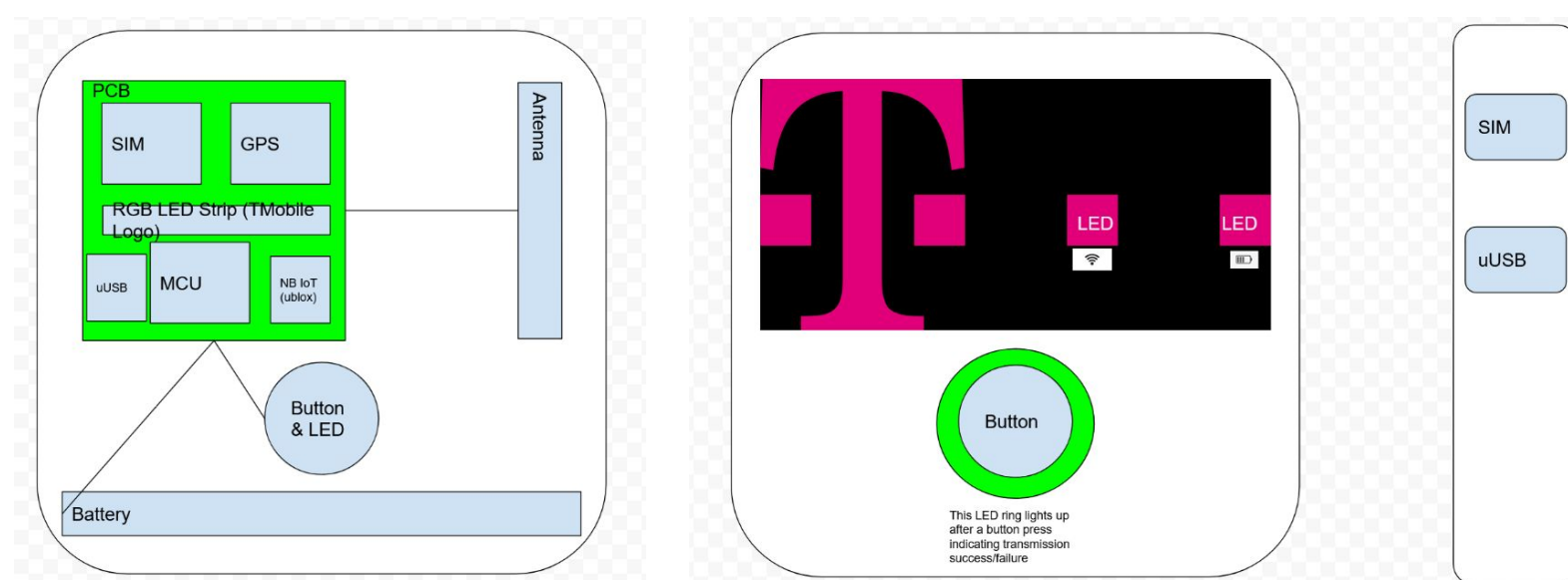
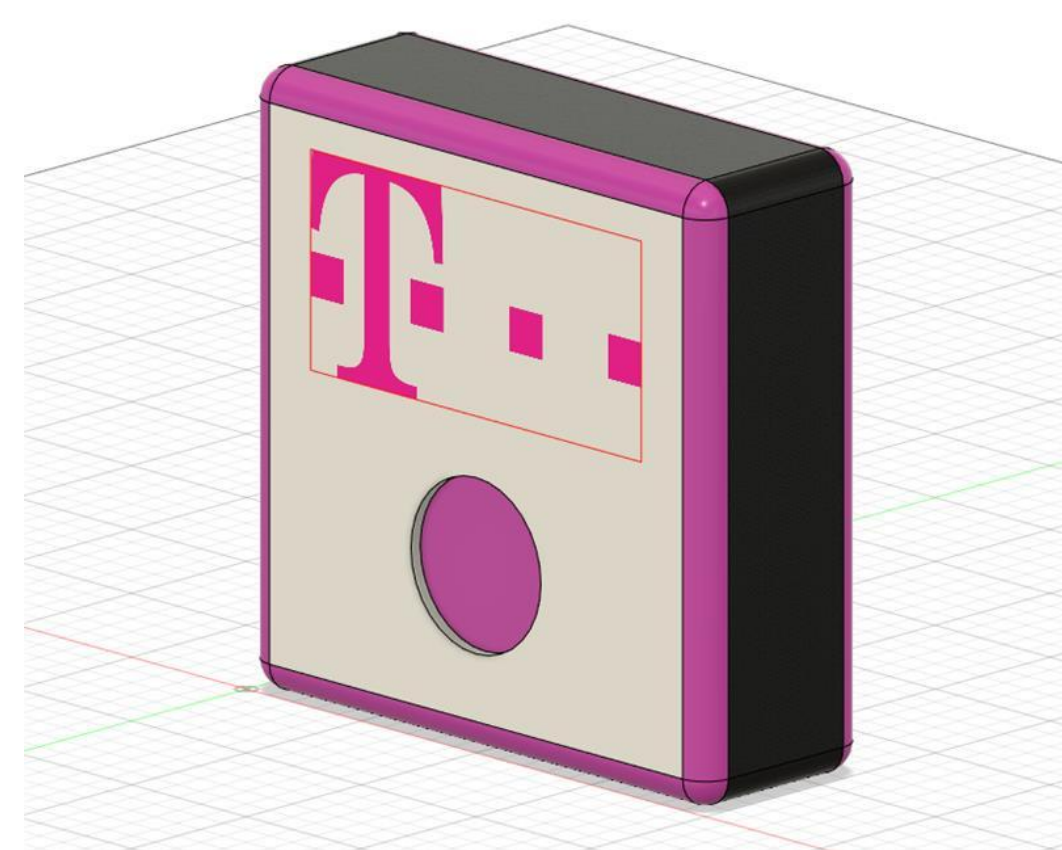
NB IoT Kit and AWS IoT

- The system uses the Twilio NB-IoT developer kit [1]
 - Push Button
 - Sensors
 - NB IoT SIM
 - Software Libraries
- When the button is pressed, communicates over the T-Mobile NB IoT network using the MQTT protocol, encrypted with TLS
- AWS IoT receives the MQTT message and executes a rule, calling the back-end Lambda function passing the Button ID and press type as a JSON.
- Single & Double-press options
- LED user feedback indicates whether a press event was successful or not
- Diagnostic information is reported once a day:
 - battery level
 - signal strength
 - GPS location



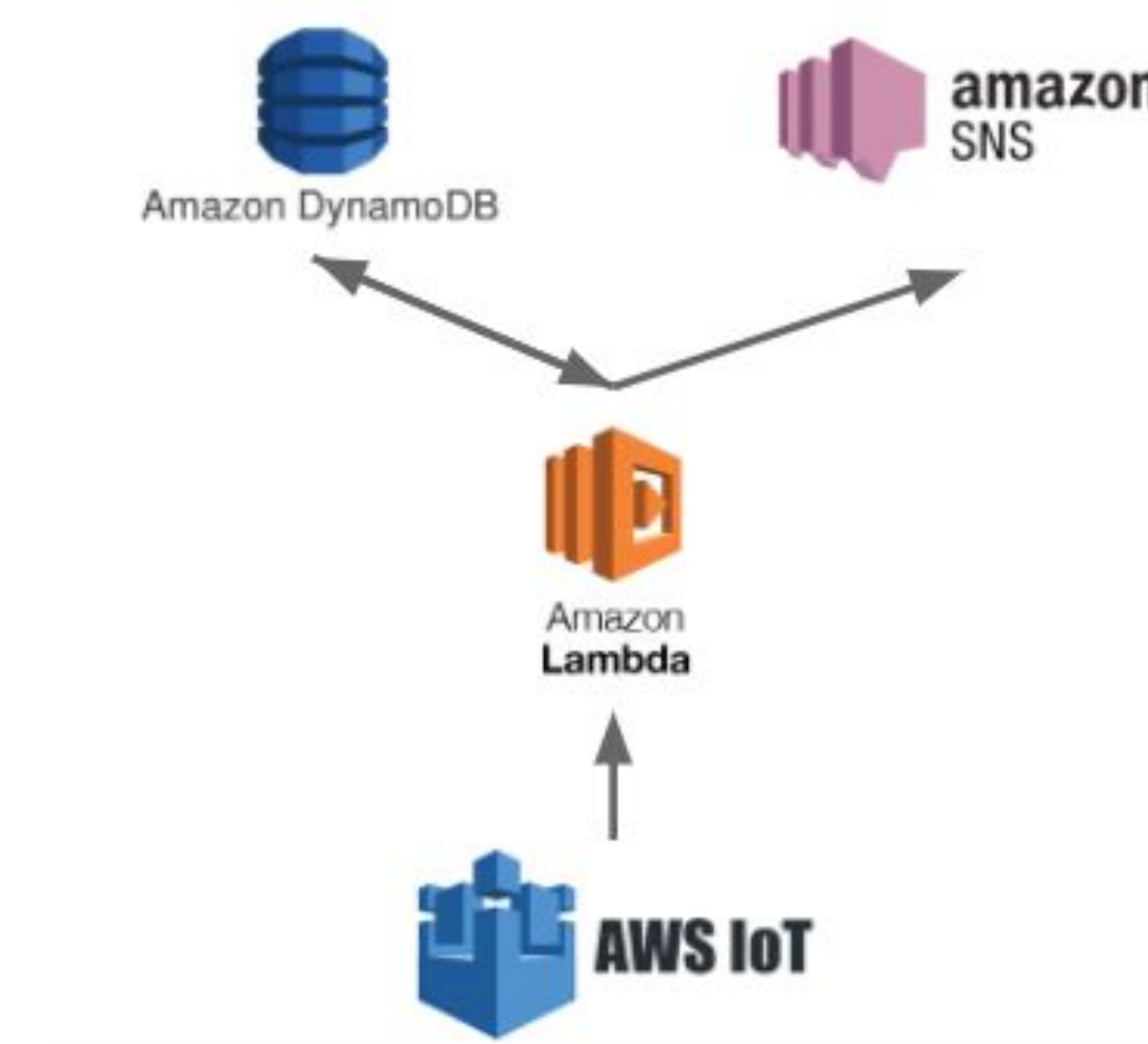
Long-Term Product Vision

- Turning this project into a product would require a custom PCB design replacing the current development kit, with a plastic enclosure (see right and below)
- There would also be further expansion and addition of more custom functions for users to select from
- The final product would also be able to perform more complex two-way communication-based tasks



AWS Cloud Connections

- A variety of AWS (Amazon Web Services) were incorporated into this project.
- Think of these as products offered by Amazon like how Apple has iPhones and iPads
- AWS IoT receives the MQTT message from the NB IoT Kit which triggers a Lambda function.
- AWS Lambda executes the desired function using the custom information set by the user.
- DynamoDB (database) stores the user's information when they enter it on the frontend.



Custom Lambda Functions and DynamoDB

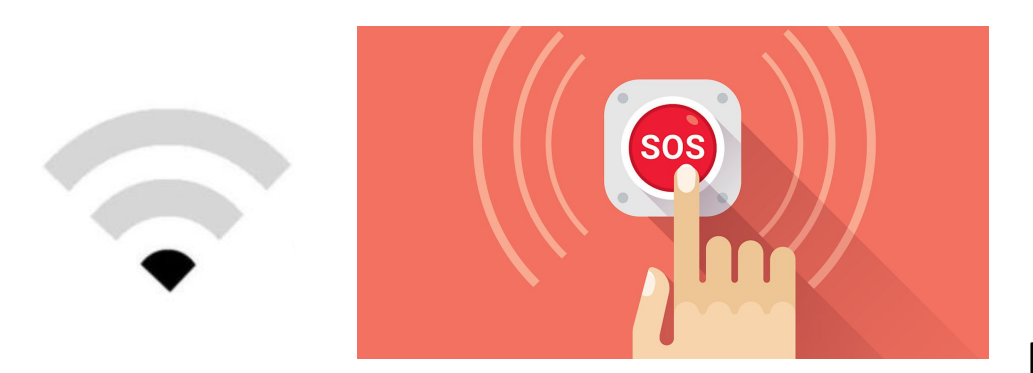
- Users interact with DynamoDB (database) through the frontend web application. The information they enter is saved straight into Dynamo.
- For example, they can choose that a single button press sends a text message with a custom message to a phone number they provide.
- Whenever a button is pressed, the event is logged along with details about the executed functions which can then be viewed under logs on the frontend website.
- Currently, there is a text message service (SMS) and an email service (SES).
- AWS Lambda handles the execution of these functions along with the logging.
- More custom functions can be written and added in the future. Companies can incorporate their own functions if they already use AWS Lambda.

Logs

BID	Date	Time	recipient	Action	Type
357404090087928	2021-05-02	16:21:50.160-07:00	+19719889562	SMS	Single Press
357404090087928	2021-05-02	16:12:26.375-07:00	+19719889562	SMS	Single Press
123	2021-04-18	16:38:31.617-07:00	isaac.li@gmail.com	SES	Single Press
123	2021-04-18	16:38:18.119-07:00	isaac.li@gmail.com	SES	Single Press
123	2021-04-18	16:37:57.978-07:00	isaac.li@gmail.com	SES	Single Press

Requirements and Use Cases

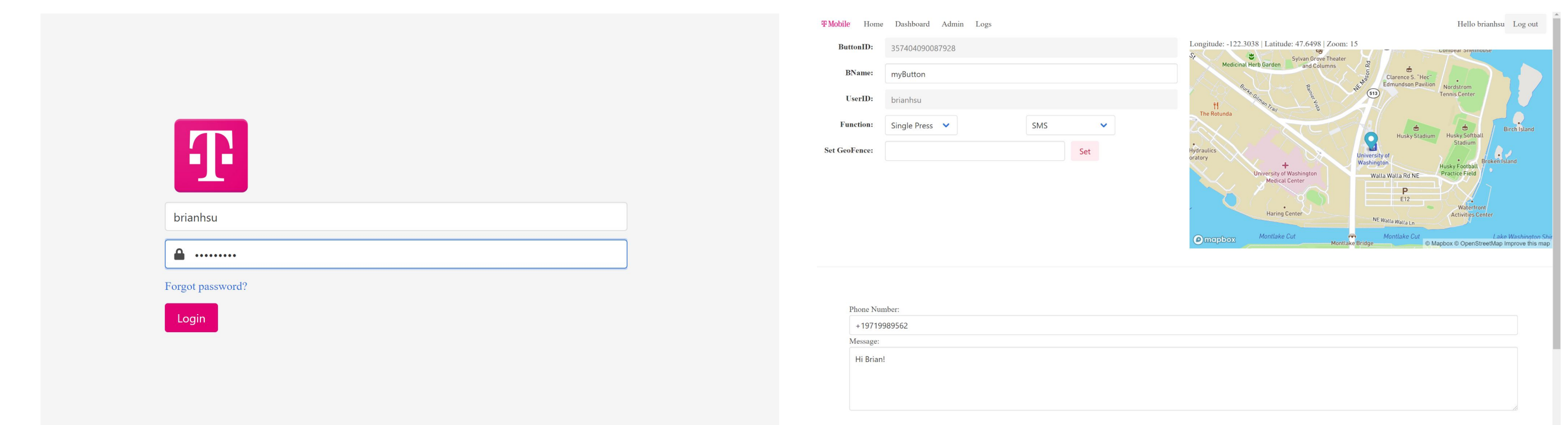
- The NB IoT kit was developed previously and provided to the group by T-Mobile.
- The main advantage of the kit is that it uses very little power and has a 10 year battery lifespan with intermittent use.
- The NB IoT button has a variety of use cases targeted at areas where it would be useful to have a low power, wifi independent solution.
- The button can be used in factories or workplaces for employees to indicate when trash needs to be picked up, supplies needs to be replaced, or machinery needs maintenance.
- The button could be used as an SOS button for taxis/drivers, for active shooter situations, in hospitals, or in homes similar to Life Alert.
- The requirements for this project were to incorporate the NB IoT kit to create an end to end product. This mainly involved setting up the cloud connections to allow for communication between the button and the cloud.



React Frontend UI & Architecture

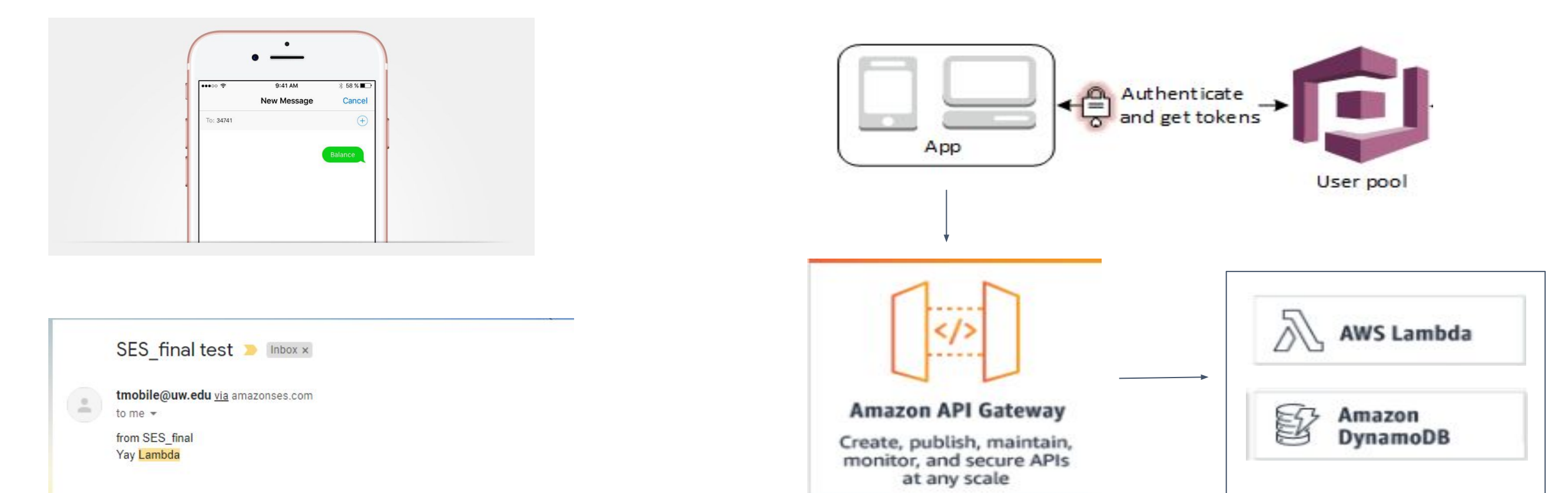
User Interface

- The frontend application was developed using React for ease of customization and scalability
- The user interface takes advantage of the Bulma CSS framework to design a responsive application for all platforms (e.g. phone, web) with intuitive user interaction.
- Register account and sign in to view dashboard and edit button functionality.
- Map display to monitor real-time button location



Architecture

- AWS Cognito User pool authenticates users to maintain session and allow access to personal buttons
- Populates application through custom API built with AWS API Gateway GET methods
- POST/UPDATE/DELETE methods trigger AWS Lambda functions to make changes to existing DynamoDB tables
- Mapbox GL JS library to present detailed visual and enable geofencing capabilities



References and Acknowledgments

- Acknowledgements: Our mentors from T-Mobile for all their guidance and support, Jeff Ahmet & Ahmad Armand
- And our faculty mentors Payman Arabshahi, James Ritcey, and Shruti Misra

[1] Twilio. Twilio Developer Kit for T-Mobile Narrowband. <https://www.twilio.com/wireless/narrowband/devkit>
 [2] AWS. AWS Developer Guide Documentation used for Lambda, API Gateway, DynamoDB, IoT, etc. <https://docs.aws.amazon.com>
 [3] Southern, Matt. "Google Launches SOS Alert For Searches Related to Coronavirus." Search Engine Journal, Search Engine Journal, 31 Jan. 2020. www.searchenginejournal.com/google-launches-sos-alert-for-searches-related-to-coronavirus/346274/.