



BOSCON

Blank Out Sign Connectivity Over Cellular Network

ELECOMP Capstone Design Project 2018-2019

Sponsoring Company:

SES America

21 Quinton St, Warwick, RI 02888

Phone: (401)-232-3370

<https://www.sesamerica.com/>

Company Overview:

Founded in 1986 in Rhode Island, SESA is a high quality multi-sign solution manufacturer for the intelligent transportation system (ITS) industry focused on providing Dynamic Message Signs and retrofit packages to clients across the United States. Manufactured in the US at their new facilities, they are fully equipped to meet clients' unique needs by delivering quality, innovative ITS products and customized solutions. Having undergone rigorous site condition testing, both hardware and software burnout test, and ITS fault simulation tests, signs produced by SES America are built to stand up in any environment. SES America's product line includes: Dynamic Message Signs (DMS), Lane Control Signs (LCS) and Blank Out Signs (BOS).

Technical Director:

David Connolly

R&D Engineer

dconnolly@sesamerica.com

<https://www.linkedin.com/in/dave-connolly-b3037b89>





Project Motivation:

Within the intelligent transportation system (ITS) industry, two major formats of signs are utilized: Dynamic Message Signs (DMS) and Blank Out Signs (BOS). Dynamic message signs are designed similar to computer monitors and are driven by designing a matrix of LED groups (called 'pixels') to create letters, shapes, and images. Blank Out Signs (BOS) offer users a means of relaying different messages to motorists in a cost-efficient package. By lighting a specific selection of the total LEDs on the sign, the sign can display up to three messages. Because the messages are predefined, a sophisticated control apparatus is not necessary. In fact, the SESA designed BOS operate with a simple dry-contact closure (relay or switch) driven by a low-cost microcontroller. This alternative to full-featured DMS makes BOS attractive for a wide variety of applications and regions. However, these BOS *lack a means of communication* - a feature necessary for operators to control and monitor signs for faults. The expensive installation of hardwired communications infrastructure necessary to control and monitor signs negates the cost advantages of the BOS products and renders remote use economically untenable.

[Last year](#), SES America sponsored a project to begin addressing this problem that utilized an embedded cellular communication module that could be interfaced with the existing BOS hardware and included a mobile-friendly web application; allowing the monitoring and control of the BOS. This year, SES America looks to expand on the work done last year to finalize the project.

Currently, the web interface has no concept of users or user authentication; meaning the Rhode Island Public Transit Authority would be able to see and manipulate the Massachusetts Bay Transportation Authority's BOS and vice-versa. Furthering this idea of user management, there needs to be an intuitive way to create new users and configure their BOS network. Currently, the only way to achieve this is by having knowledge of web development, where every new page and user must be created manually.

The Arduino microcontroller communication and message response system currently fails on unexpected messages; it assumes that all incoming messages are successes and has no fall back/error handling for corrupted or failed messages. A more robust communication system is essential for ensuring that the microcontroller can gracefully receive unsuccessful messages to prevent failure of the system and ensure it can still operate as expected.

Lastly, the microcontroller currently lacks a bootloader, which essentially is a program to load the firmware of a device into memory. This allows the microcontroller to be automatically programmed, contrasting with the need for an external programmer to load it every time it turns on.



Anticipated Best Outcome:

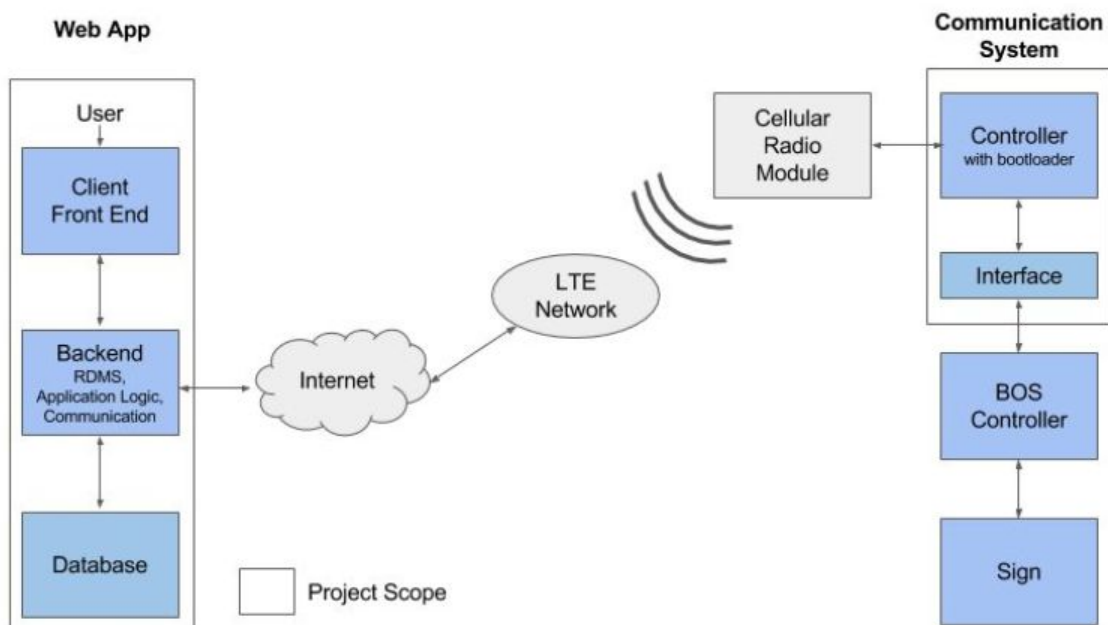
A production-ready, modularized cellular communication system, which can be interfaced with the current BOS architecture. The web application must be able to support multiple users, respecting data confidentiality and integrity, to ensure that user data is not able to be read or overwritten. The web application must also have an accompanying configuration tool that allows a user to seamlessly create and alter a network of BOS, without the need for web development knowledge. The microcontroller's message response system must be fault tolerant to ensure the reliability of the system. The microcontroller must also have a bootloader to allow remote microcontrollers to start up on their own.

Project Details:

Overall system concept:

A configuration tool will allow the creation of new users' pages and the ability to set up their networks of BOS. This configuration tool will interact with the database of the web-app to insert information about the signs. The microcontroller will have a more robust message response system that will allow it to remain fault-tolerance in the event that it receives unexpected messages. The microcontroller will also contain a bootloader that will allow it to be able to be booted up without the need to manually program it every time.

Block Diagram:





Firmware Tasks:

- Creation of a bootloader for the firmware on the Arduino microcontroller.

Software Tasks:

- Creation of a user system that supports multiple independent users that have no read or write privileges for other users' BOS networks.
- Creation of a configuration tool that will allow a user to configure a network and populate the database with the networks

Composition of Team:

2 Computer Engineers

Skills Required:

Computer Engineering Skills Required:

- Experience with Arduino microcontrollers
- Experience writing firmware (C/C++)
- Client side web development (Javascript, HTML, CSS)
- Server side web development (PHP, SQL)
- Understanding of network protocols



Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

By providing a low-cost monitoring solution for blank out signs, SES America will increase their marketability and differentiate themselves from their competitors. Increased monitoring and control functionality will allow SESA to meet the demands of different markets; such as cities - increasing their products' scope.

Broader Implications of the Best Outcome on the Company's Industry:

With proper fault detection, blank out signs can be implemented to indicate hazards with a lesser risk of danger due to hardware failure. With this increased functionality, blank out signs can be deployed in rural areas of the nation and on long stretches of highways and freeways; wherever a cell network is available. Further implications include response-based BOS interfaced with speed or traffic sensors to alert motorists of danger. The low-cost, manageable and smart system proposed by SES America will directly affect and improve road safety in the United States.