CLEAR

LED Sequential Communication Protocol Application

ELECOMP Capstone Design Project 2025-2026

Sponsoring Company:

VoltServer Inc.
42 Ladd St, Suite 227
East Greenwich, RI 02818
http://www.voltserver.com

Company Overview:

VoltServer's founder and CEO, Stephen Eaves, knew the energy sector needed smarter, transformation-friendly solutions. His goal was simple: to make electricity inherently safe. With his 15 patents and patents pending for energy storage and power conversion, Eaves set out to make his mission a reality. Thanks to great leadership, partners, and venture capital backing, VoltServer® began shipping products in early 2014. Our patented Digital Electricity® solution revolutionizes how power is distributed across buildings, campuses, and even cities. From our headquarters in East Greenwich, Rhode Island, VoltServer® continues to develop and deliver our innovative power distribution platforms. Today, you'll find our Digital Electricity® powering over 1000 large sports stadiums, office towers, hotels, condominiums, medical buildings, and more. We enable 5G mobile communications, intelligent building optimization, and high-yield indoor agriculture with the power of safe, high-voltage energy.

Technical Director:

Camilo Giraldo, URI '17
Sustaining & Test Engineering Team Manager
camilo.giraldo@voltserver.com
https://www.linkedin.com/in/camilo-giraldo-b41a73b6

VOLTSERVER®
DIGITAL ELECTRICITY®

Project Motivation:

VoltServer's devices are built with integrated colored LEDs that display status codes to the user by displaying different sequences of LED blinks. There are generally three LEDs; one blue, one green, and one red. The status codes for each device are different but the same type of light blinking sequences combining the three lights are used across the entire Digital Electricity® family of products.

The problem we consistently run into in the field, and at times in our lab, **is the need for VoltServer® engineers and technicians to be able to decipher the LED blink codes.** Our current system relies on the user to know what each LED blink code means. However, more commonly and even more frustratingly, technicians end up having to look up this up. That entire process can be extremely cumbersome and inefficient. Furthermore, VoltServer® engineers have identified an opportunity to embed real data into the LED blink codes. The idea involves using a cellphone camera to detect what LED codes are actively being displayed by the device. With the increased framerate that a cellphone camera can achieve compared to the human eye, it is our opinion here at VoltServer®, that it's possible to embed real data strings by blinking the LEDs at a high frequency.

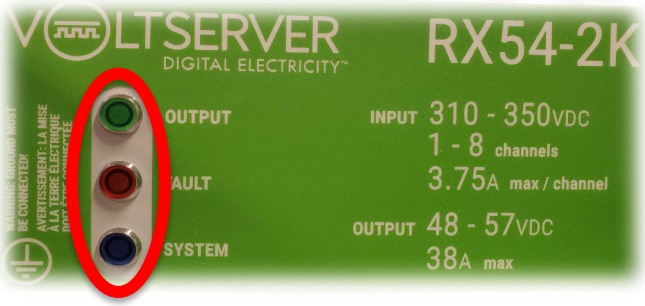
Anticipated Best Outcome:

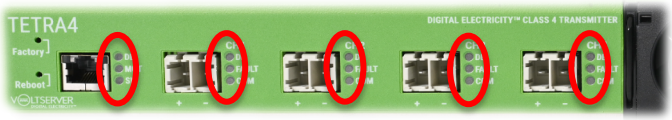
The Anticipated Best Outcome consists of the development of a proof-of-concept cellphone application that can "look at" blinking LEDs on a VoltServer® device through the cellphone's camera and can determine what the LED code is telling the user. The team is also expected to develop a blink code test board with embedded microprocessors, sensors, and LEDs that will be used to simulate VoltServer® LED codes and eventually the LED embedded data portion of the project. The best outcome consists of both the cellphone application and the blink code test board working together to demonstrate the feasibility of embedding data through the LEDs using this methodology.

- A complete bill of materials for the blink code test board
- Well commented firmware and application source code and compiled binaries, if applicable
- A system user manual describing the hardware, firmware, and application, as well as any necessary descriptions or justifications, where applicable
- Schematics, layout, fabrication, and assembly files for PCB

Project Details:

LEDs on Existing VoltServer® Products:





Requirements for Blink Code Test Board:

- Design must be able to simulate the different LED sizes and light intensities normally used on VoltServer® products
- Design can simulate simple LED codes readily observed on existing VoltServer® products
- Design is capable of high frequency switching of the LEDs
- Design is capable of LED pulse-width modulation
- Design employs temperature and current sensors to ensure safe LED operation
- Design must follow proper PCB design rules established by VoltServer®

Requirements for Cellphone Application:

- Application establishes cellphone camera for video processing or high frequency image processing
- Application can tell if an LED is on or off
- Application can determine color of LED
- Application can determine frequency at which LEDs are being switched
- Application can sense pulse-width modulation of LEDs
- Application can recognize data being pulsed on the LEDs at high frequency

Hardware and Electrical Tasks:

- Identify potential major system components: LEDs, embedded processor, DC/DC converters, sensors, etc.
- Develop schematics for blink code test board, identifying how all system requirements are being met.
- Layout design of blink code test board
- Build and validate blink code test board
- Document all aspects of the hardware development and subsequent testing

Application Development:

- Establish control of video or high frequency camera on cellphone
- Develop image processing software capable of distinguishing color and intensity of light
- Accurately detect LED sequences from colored LED arrays
- Accurately read data from LEDs when available
- Convey LED sequence messages to user via cellphone GUI
- Develop graphical user interface for monitoring and saving LED sequence/data stream

Composition of Team:

1 Electrical Engineer & 1 Computer Engineer

VOLTSERVER®
DIGITAL ELECTRICITY®

Skills Required:

Electrical Engineering Skills Required:

- Low power embedded circuit design
- Voltage regulation circuit design
- Microprocessor circuit development
- Sensor circuit design
- Schematic capture
- PCB layout

Computer Engineering Skills Required:

- Application design
  - Cellphone GUI design
  - Cellphone peripheral implementation
  - iOS or Android implementation (Preferably both)
- Microcontroller FW design, written in C coding language
- Sensor FW implementation

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

Having a functioning proof-of-concept for testing will allow VoltServer® the ability to convert LED-sequence based error messages and status codes into a readable format on an on-demand basis. Furthermore, using this new communication protocol through the LEDs will allow us to broadcast even more information to the user in a much quicker and more concise manner than previously possible.

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

Being able to make device status data and information available on the face of the unit via the LEDs will open an avenue for VoltServer® products to display better status messages that give more information about what is going on with the device. This ability to give more insight upfront will save us time in the long run. Also, being able to accurately decipher LED sequences on-demand will help technicians accurately troubleshoot our products, which will ultimately be reflected in the amount of VoltServer® units that are misdiagnosed as "faulty" in the field.