

BeaconSafe Project Plan, Budget, and Justification

1. Executive Summary

The BeaconSafe project is designed to address roadside safety challenges by providing high-visibility beacons equipped with modular control systems and long-range communication capabilities. These units are designed to improve safety for motorists, emergency responders, and roadside service teams, particularly in low-visibility conditions or emergencies.

Each BeaconSafe unit will serve as a highly visible roadside beacon, alerting oncoming traffic to potential hazards, reducing the risk of secondary accidents, and enabling more efficient communication with emergency services.

2. Project Goals and Scope

BeaconSafe aims to provide long-term, permanent installations of roadside safety beacons along highways to enhance visibility and communication during emergencies. The system will be modular and adaptable, with future plans for smart city integration, crash detection, and interaction with autonomous vehicles.

Municipal integration and first responder control are essential. Live monitoring of the beacons will allow municipalities and emergency services to interact with and control beacons in real-time, improving

overall emergency response and public safety.

3. Technical Specifications

Each BeaconSafe unit will be equipped with high-intensity 10,000-lumen LEDs, modular control systems, and multi-mode communication (Wi-Fi and LoRaWAN). The system will operate in all weather conditions and have power redundancy through solar and grid-powered backups. LoRaWAN 1.1 will be implemented to support relaying functionality and network scalability. Real-time monitoring for municipal and emergency use is a core feature.

4. Budget Breakdown

Prototype Budget (Single Unit):

- Hardware (Wi-Fi, LoRaWAN, Control, LED, Power): \$1,080 CAD per unit**
- Software Development: \$27,000 CAD**
- Engineering & Integration: \$19,000 CAD**
- Installation: \$1,000 CAD per unit**
- Project Management & Overhead: \$12,000 CAD**

Total Estimated Cost for Prototype: \$60,080 CAD

10-Unit Deployment Budget: \$42,800 - \$49,800 CAD

50-Unit Expanded Deployment Budget: \$104,000 - \$106,000 CAD

Future Phases:

- AI Integration, Ruggedization, V2I: Approx. \$175,000 CAD across phases**

5. Communication Infrastructure

The BeaconSafe system will rely on a combination of Wi-Fi for local interaction and LoRaWAN 1.1 for long-range communication.

The LoRaWAN relay functionality allows each beacon to act as a relay, extending network range while reducing the need for additional gateways. First responders and municipalities can monitor and control beacons in real-time for emergency or roadside service situations.

Gateways will be placed based on terrain and network needs, ensuring redundancy and real-time municipal control.

6. Justification for Technology Choices

LoRaWAN is chosen for its long-range, low-power capabilities. It allows communication over large areas with minimal infrastructure. Relay functionality allows beacons to extend coverage without requiring dense gateway placement, making it ideal for highway and remote environments. Wi-Fi ensures ease of local activation for stranded motorists or first responders.

NB-IoT is considered for areas with cellular coverage but would add ongoing operational costs. LoRaWAN is favored due to its low total cost of ownership and proven reliability in smart city use cases.

7. Deployment Strategy

Beacons will be deployed at intervals appropriate for the roadway. Municipal partnerships will be key in leveraging existing infrastructure (e.g., telephone poles) to reduce installation costs. First responders can activate or control beacons remotely in real-time, enhancing emergency response.

Municipalities will monitor the network continuously, ensuring that real-time data from the beacons informs roadside services and public safety measures.

8. Future Phases and Scalability

Future phases will incorporate AI for traffic monitoring, crash detection, and V2I communication to support autonomous vehicle interaction. Smart city integration will allow municipalities to automate responses and track infrastructure conditions in real-time.

Ruggedized versions of the beacon will be developed for deployment in harsher environments.

9. Conclusion

BeaconSafe offers a scalable, cost-effective, and future-proof solution for

roadside safety, with the flexibility

to expand into urban and rural environments. Its modular nature and forward-looking technology choices ensure

that the system is adaptable and capable of meeting future demands.

10. Disclaimer

The estimates provided in this document are based on AI projections and should be further refined through

collaboration with subject matter experts. Costs and specifications may vary based on actual implementation and vendor selection.

11. References

1. LoRaWAN Standard Expands to Include Relay Specification:
<https://resources.lora-alliance.org/home/lorawan-standard-expands-to-include-relay-specification>

2. Municipal IoT Integration and Smart City Deployments:
<https://www.i-scoop.eu/internet-of-things-guide/smart-cities-iot/>

3. LoRaWAN Real-Time Monitoring Use Cases in Municipalities:
<https://www.thethingsnetwork.org>