# Carrive Dynamic Routing Solution

## A Scalable, Market-Ready Geospatial Routing Platform

Carrive Technologies

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# 1. Executive Summary

Carrive is a dynamic routing and network mapping solution designed to deliver real-time routing and asset visualization capabilities. Built using a Flask backend, PostGIS with pgRouting, and a sleek Leaflet front-end, Carrive is ideal for industries such as logistics, oil & gas, and utilities. The solution is highly scalable, with deployment options via Docker or AWS EC2, and comes with a modern, market-ready UI.

# 2. Project Overview

## 2.1. Objectives

– Develop an interactive web application for real-time routing and network visualization.

– Enable users to set start and destination points, which are snapped to the nearest network vertices.

– Compute and display the shortest route using dynamic queries against a PostGIS database with pgRouting.

– Provide flexible deployment options to meet various enterprise requirements.

## 2.2. Key Features

1. **Interactive Map Interface:** A sleek, user-friendly UI with a dark mode theme and minimalist controls.
2. **Dynamic Routing:** Real-time snapping of GPS coordinates to network vertices and dynamic route computation.
3. **Flexible Deployment:** Deployable using Docker containers for consistent environments or via AWS EC2 for scalable cloud hosting.
4. **Modern Aesthetics:** A premium user experience with an Uber-like design, ensuring an intuitive and professional interface.

# 3. System Architecture

## 3.1. Components

**Frontend:** – Built with HTML, CSS, and JavaScript using the Leaflet library for interactive maps.

**Backend:** – Python Flask providing RESTful endpoints for snapping markers and computing routes.

**Database:** – PostGIS-enabled PostgreSQL storing geospatial data, with pgRouting handling shortest path calculations.

### 3.2. Deployment Options

- **Docker:** Containerized deployment for consistent environments and ease of replication.
- **AWS EC2:** Scalable, cloud-based hosting with integration into the broader AWS ecosystem.

## 4. Technical Implementation

### 4.1. Flask Backend

The backend is implemented in Python using Flask. Key endpoints include:

- **/closest_vertex:** Receives raw GPS coordinates (assumed in EPSG:4326), transforms them, and returns the nearest network vertex (ID and coordinates).
- **/shortest_route:** Accepts two vertex IDs and computes the shortest path between them using pgRouting. The result is returned as an ordered JSON array of route points.

### 4.2. Frontend Interface

The user interface uses HTML/CSS/JavaScript and Leaflet to create:

- A full-screen map with a white basemap.
- Draggable markers for start and destination (using default icons).
- Custom zoom buttons and a floating sidebar with modern controls.
- A dark-themed header with the app name "CARRIVE" to emphasize branding.

### 4.3. Integration Flow

1. The user sets start and destination markers on the map.
2. When "Calculate Route" is pressed, each marker's coordinates are sent to the `/closest_vertex` endpoint to snap them to the nearest network vertices.
3. The returned vertex IDs are then used to call the `/shortest_route` endpoint.
4. The computed route is returned as JSON and displayed as a polyline on the map.

## 5. Budget & Cost

### 5.1. Estimated Costs

- **Development:** $10,000 - $20,000 (depending on scope and customizations).
- **Deployment (Docker):** Minimal cost if self-hosted; $50 - $200 per month for cloud container hosting.
- **Deployment (AWS EC2):** $100 - $500 per month, depending on instance size and usage.
- **Maintenance & Support:** $2,000 - $5,000 annually.

### 5.2. Cost Benefits

- Reduced operational costs through optimized route planning.
- Scalable architecture allows gradual investment as usage increases.
- Open-source technologies minimize licensing fees.

## 6. Benefits to Target Industries

- **Logistics:** Optimized delivery routes and fleet management.
- **Oil & Gas:** Efficient planning for pipeline inspections and field operations.
- **Utilities:** Streamlined network maintenance and rapid response for outage management.

## 7. Conclusion

Carrive delivers a robust, dynamic routing solution designed with modern aesthetics and scalable architecture. Whether deployed in a Docker container or on AWS EC2, it provides real-time route computation, an intuitive user interface, and flexible integration with existing enterprise systems. This solution is ideal for any organization needing advanced geospatial analysis and routing capabilities.

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