

OPTIMAL EV ROUTING

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PROBLEM STATEMENT

School Bus Routing Problem (SBRP) is a challenging NP-hard problem in the field of transportation that involves creating effective routes for school buses to pick up and drop off students. It involves:

- 1. Capacity constraints:** Number of students that can be accommodated in the Bus etc.
- 2. Time constraints:** The maximum drop off time for each student is minimised.
- 3. Cost optimization:** Minimum cost to be spent for transportation.

GOALS AND OBJECTIVES

Objective n° 1

To provide *GUI* (*Graphical User Interface*) with **Google Maps!** to display routes and solve the **School Bus Routing Problem** in real time dynamically

Objective n° 2

To provide innovative solutions specifically for **EV vehicles** by including their **battery percentage, battery charging stations, cargo weight, speed** etc.

Objective n° 3

Apply it to real life situations like **Garbage Collection, Depot Cargo Delivery** for better and efficient transportation and savings by reducing latency with **parallel API calls** and **refactoring**



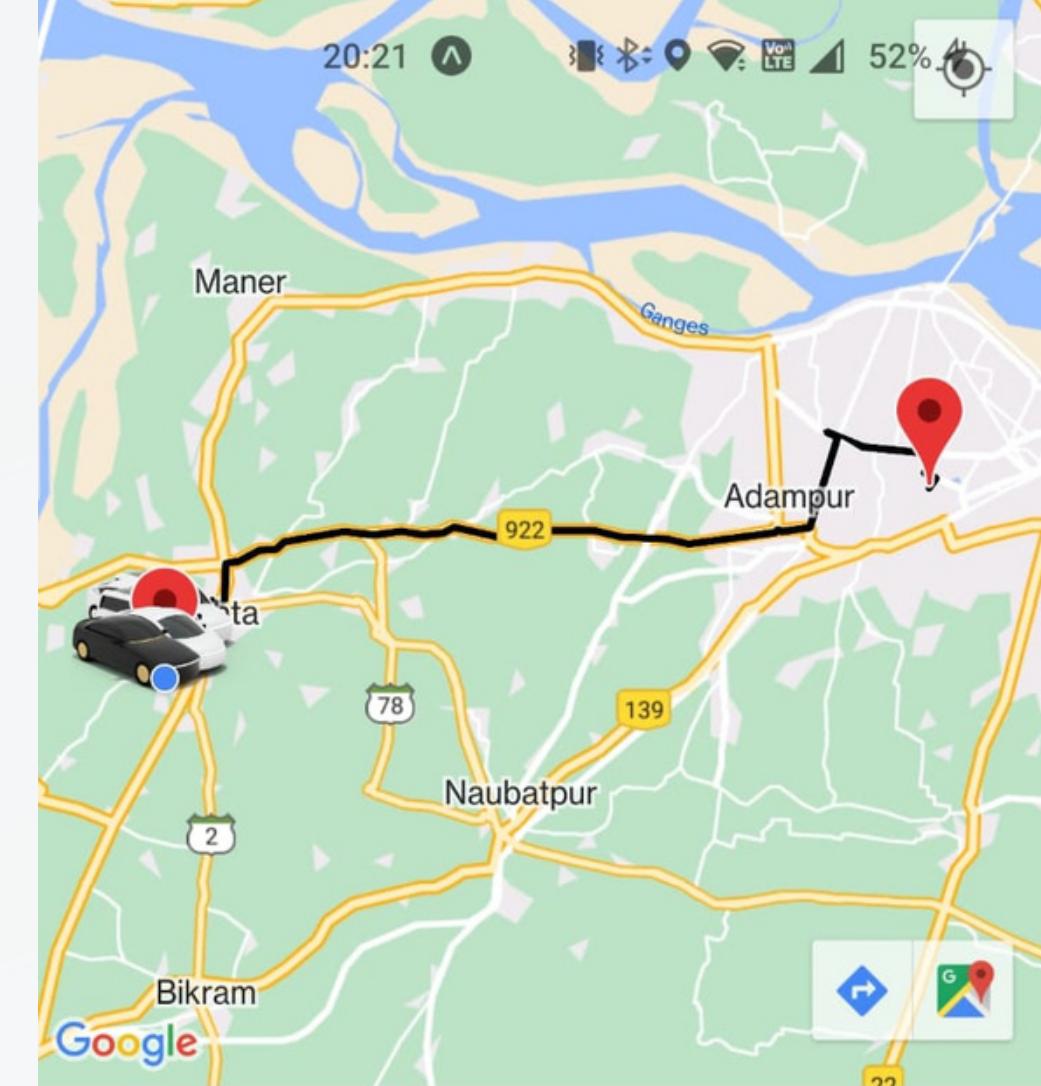
FIRST BUILD v1.0



Platform independent React Native application for mobile systems with ability to select single source - single destination. Built keeping in mind about ZapCab - Cab Sharing App built earlier.



Reports the estimated cab arrival time, source to destination distance, source to destination time based on real time traffic data and the approximate cost based on actual estimated fuel consumption values (doesn't include option for EVs).



Select a Ride - 33.1 km (1 hour 11 mins)



ZapX
ETA: 5 mins

£71.33

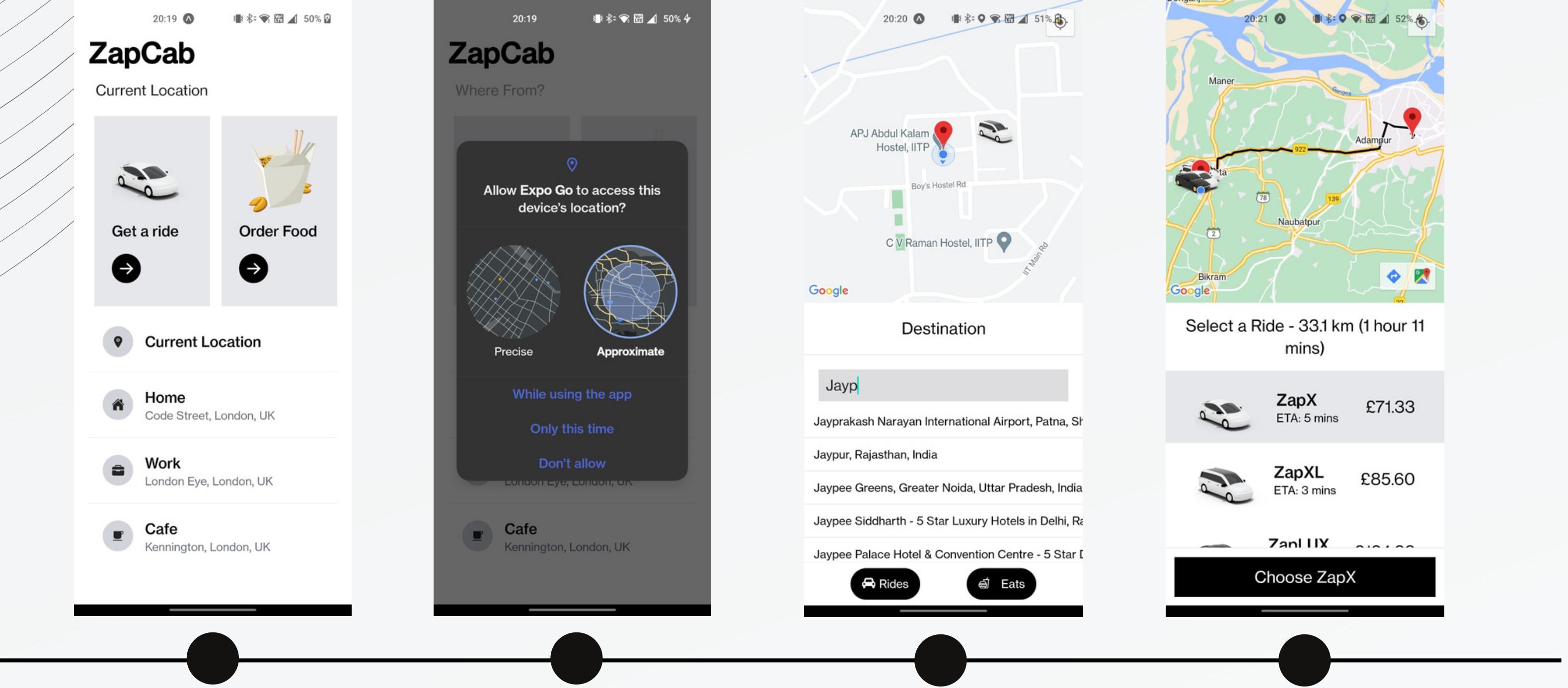


ZapXL
ETA: 3 mins

£85.60

ZapLUX

Choose ZapX



HOME PAGE

Landing home page. Select Source using 3 methods – Google Autocomplete Search, Current Location using GPS Access or Most-frequently travelled tab

LOCATION ACCESS

Ability to get Current Location requires Permission. Separate platform independent permissions supported for both iOS and Android

DESTINATION

Similar selection options as Source. Points a marker at the Source with Cabs shown nearby the Source with a car marker..

TRIP

Plots fastest Source to Destination Route with Time, Distance and Cost Matrix APIs of Google Cloud

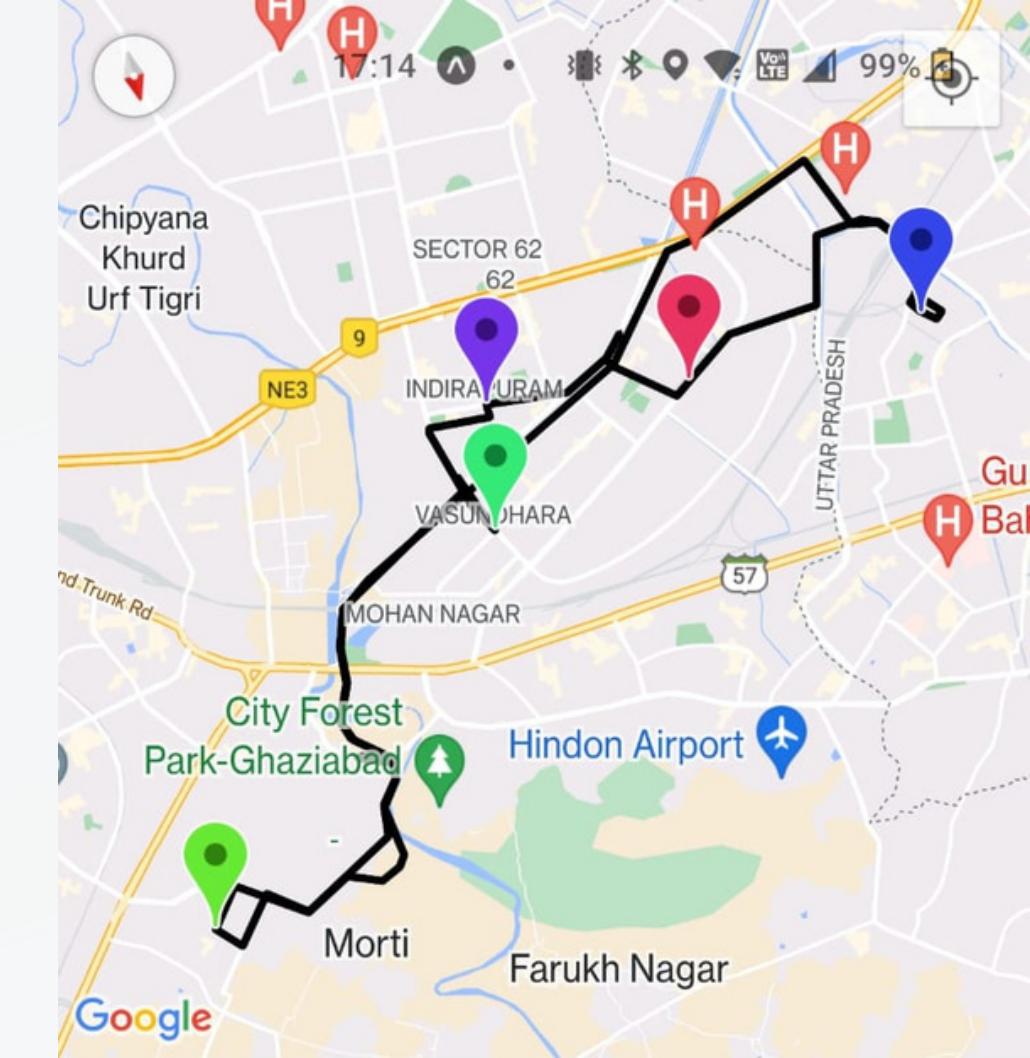
SECOND BUILD v2.0



Using Node.js and Express.js in the backend, we are now able to process single source-multiple destination queries from the frontend more effectively using Travelling Salesman Problem solution based on heuristics like Nearest Neighbours.

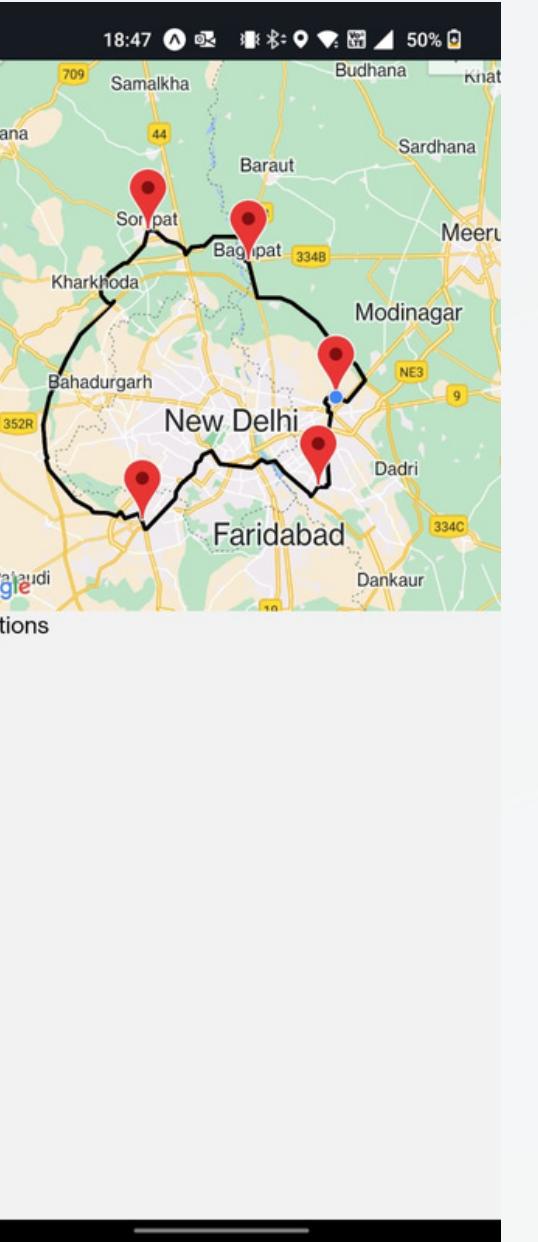


Reports the current city, the next city, the distance and the time based on real time traffic data and the approximate cost based on actual estimated fuel consumption values (still doesn't include option for EVs).



ZapRoutes

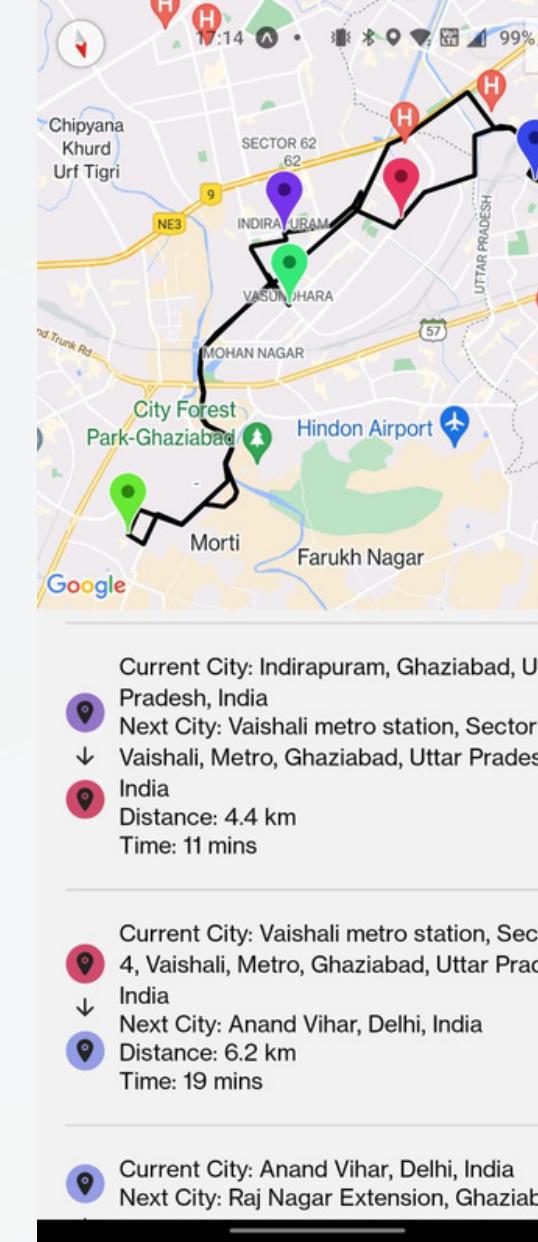
- Current Location - +
- Vasundhara, Ghaziabad, Uttar Pradesh -
- Indirapuram, Ghaziabad, Uttar Pradesh -
- Vaishali metro station, Sector 4 -
- Anand Vihar, Delhi, India -



EARLY DEVELOPMENT

Select Source using 2 methods - Google Autocomplete Search, Current Location using GPS. Select Multiple Destination with Google Autocomplete

Ability to plot TSP Route for single source - multiple destination. However, no helpful GUI for users was provided



FINAL BUILD UI

Final build released with coloured pins for user-friendly UI/UX. Similarly, Current, Next, Time and Distance was added

```
latitude: 28.7030425,
longitude: 77.430373,
text: 'Raj Nagar Extension, Ghaziabad, Uttar Pradesh, India',
distance: 0,
time: 0,
color: 'hsl(103, 50%, 50%)'

},
{
id: 0.47988469261422156,
latitude: 28.6623758,
longitude: 77.37344,
text: 'Vasundhara, Ghaziabad, Uttar Pradesh, India',
distance: 11999,
time: '19 mins',
color: 'hsl(142, 58%, 56%)'

},
{
id: 0.654332361379314,
latitude: 28.6460176,
longitude: 77.3695166,
text: 'Indirapuram, Ghaziabad, Uttar Pradesh, India',
distance: 2930,
time: '8 mins',
color: 'hsl(261, 43%, 62%)'

},
{
id: 0.6969870848937608,
latitude: 28.6502735,
longitude: 77.3391456,
text: 'Vaishali metro station, Sector 4, Vaishali, Metro, Ghaziabad, Uttar Pradesh, India',
distance: 4413,
time: '11 mins',
color: 'hsl(345, 58%, 55%)'

},
```

BACKEND

Built on Node.js and Express, it solves the TSP using Heuristics and calls Google Cloud APIs parallelly for average response time of 80ms

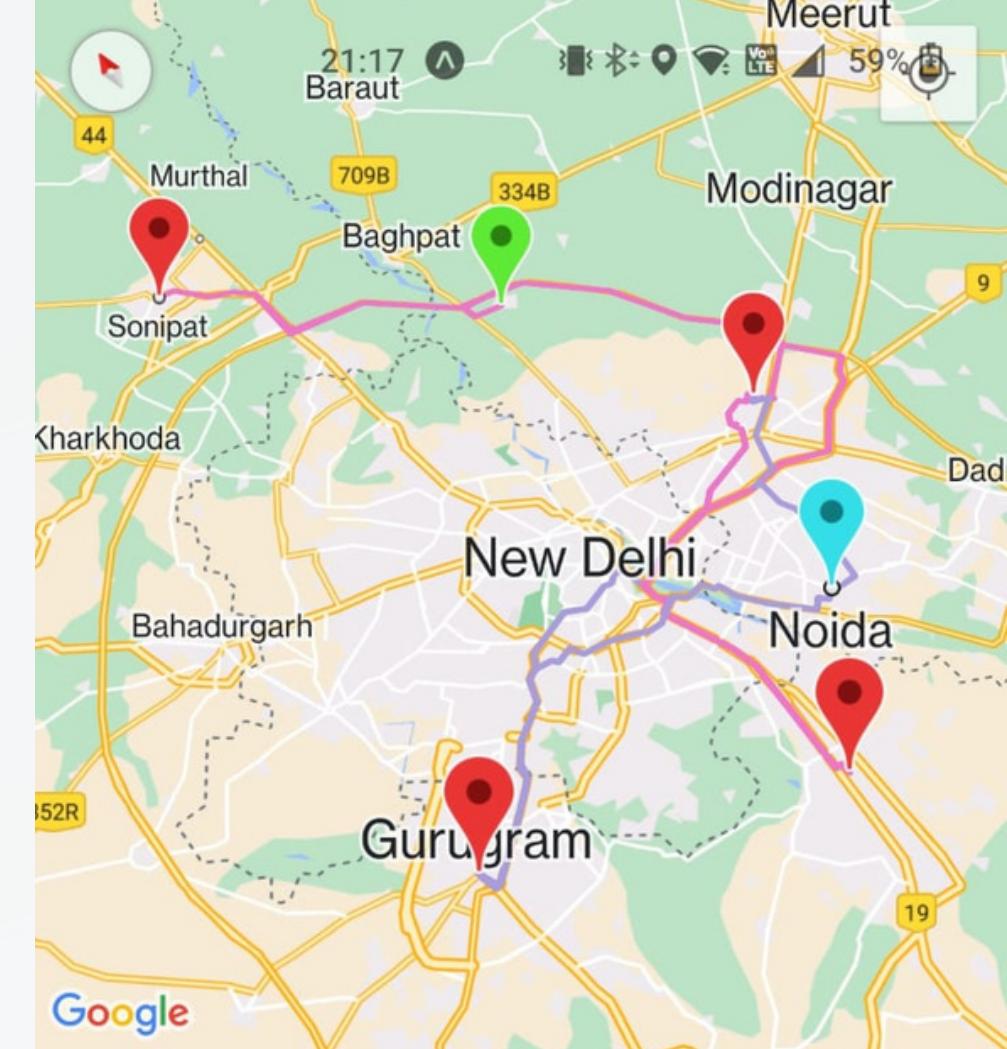
FINAL BUILD v3.0



The latest version now integrates support for Electric Vehicles, enabling users to incorporate Battery Charging and Swapping Stations along the routes. Additionally, routes are optimized considering factors such as weight capacity, vehicle speed etc.



Reports the current city, the next city, the time and the approximate cost incurred based on actual battery consumption/swapping values. C++ backend supports minimum latency with average response time of 80ms.



Directions

▼ Vehicle 1:

▼ Vehicle 2:

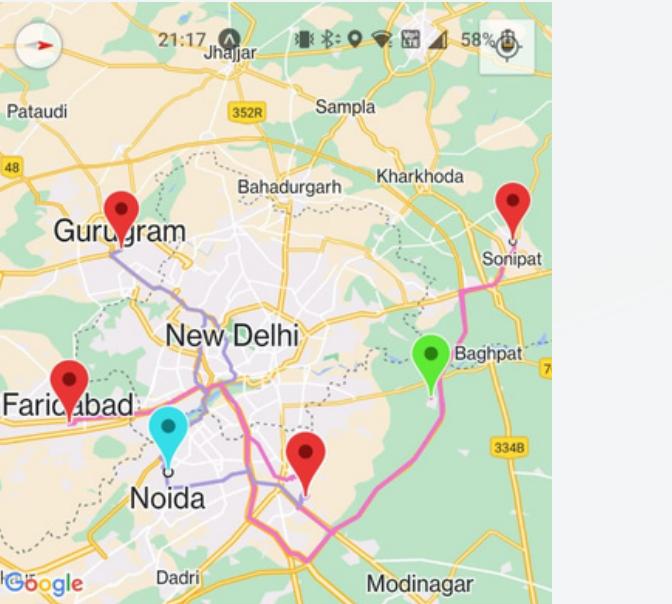
The screenshot shows the ZapRoutes app interface. At the top, there's a header with the app name and some status icons. Below it, the main area is divided into sections:

- Locations**: A section with a "Where To?" input field and a "Demand Weight" slider.
- BatteryChargingStation**: A section with a "Battery Charging Station" input field and a location pin icon.
- BatterySwappingStation**: A section with a "Battery Swapping Station" input field and a location pin icon.
- Vehicles**: A section with vehicle parameters: mxBatteryLevel, mxCostAllowed, and mxWeightAllowed.

At the bottom right of this panel is a large circular button with a right-pointing arrow.

HOME PAGE

Select Locations, Battery Charging Stations and Battery Swapping Stations using Google Autocomplete. Also set each vehicle's parameters for accurate routing.



Directions

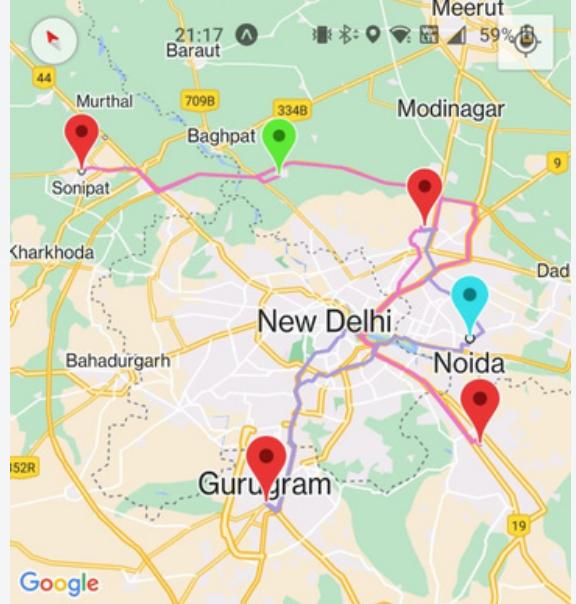
▲ Vehicle 1:

Time: 14.4392
Cost: 3451
Route:

Current: Raj Nagar Extension, Ghaziabad, Uttar Pradesh, India
Next: Faridabad, Haryana, India

Current: Faridabad, Haryana, India
Next: Khekra, Uttar Pradesh, India

Current: Khekra, Uttar Pradesh, India
Next: Sonepat, Haryana, India



Directions

▼ Vehicle 1:

▼ Vehicle 2:

```

Final length: 8215
Final length: 4715
Charge required: 1774.5
2900
Charge required: 1247.5
1910
Mxvehicles2
Mxvehicles2
Mxvehicles2
Mxvehicles2
Mxvehicles2
0 -> 1 -> ch-st(2) ->
Total time taken: 14.4392
0 -> 2 -> Bat-swap(1)
Total time taken: 8.586
FINAL ANSWER: MAXIMUM TIME TAKEN
|
```

USING STATIONS

The EV Vehicles can now utilise the Battery Charging and Swapping Stations to complete their route. Blue Marker - Battery Swap Station. Green Marker - Battery Charge Station

MULTIPLE VEHICLES

Whether a vehicle is big or small, we now have the ability to plan routes based on Battery Percentage, Capacity, Speed, Cargo Weight etc.

BACKEND

Built on C++ and Node.js, it solves the TSP using Heuristics and calls Google Cloud APIs parallelly for decrease in latency time of 100ms.

FUTURE PROSPECTS

Deal with multiple sources and then implement the same algorithm using Heuristics

MULTIPLE SOURCES

Implement better heuristics which take much lesser time for Optimal Route calculation for faster serve times and user retention

BETTER HEURISTICS

Improve UI and implement Animations in later stages. Separate application for Drivers and option for real-time tracking

UI CHANGES

THANK YOU

