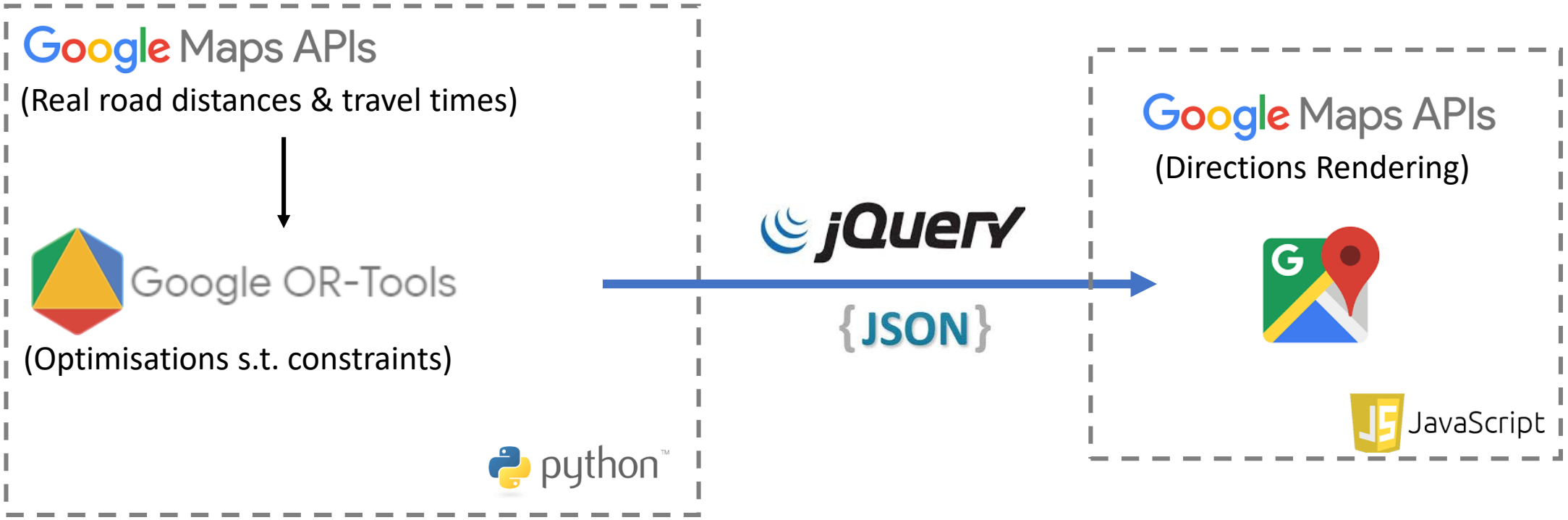
Route Optimization for Real World Locations using Google Maps & Google OR tools

Subject to the following constraints:

- Multiple Way Points
- Multiple Vehicles
- Fixed Capacity
- Fixed Time Windows

For demonstration purposes the business of **Asia Pacific Breweries** has been assumed as a client, requiring a transportation plan for delivery of product from their **manufacturing facility** to **multiple distribution centres.**

Tools Used
& Overall Application Framework



Shortest Path & Travelling Salesman

Route Summary
Departure Time: Fri Oct 05 2018 15:31:18
GMT+0800 (Singapore Standard Time)

A to B
Asia Pacific Breweries -> Pacific Beverages
Duration: 9 mins**, Distance:** 6.4 km

B to C
Pacific Beverages -> Radjawali Distribution
Duration: 21 mins**, Distance:** 16.1 km

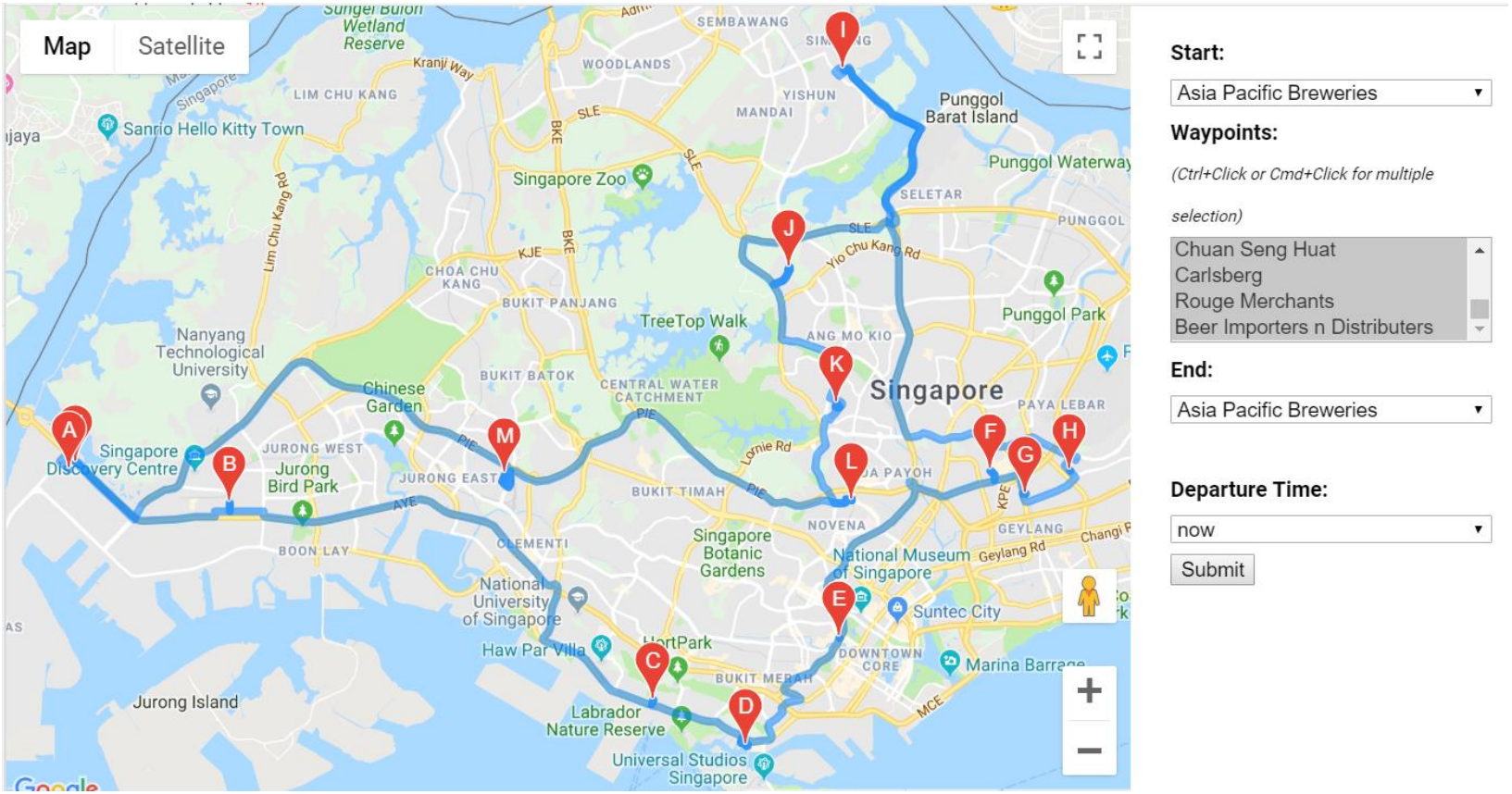
C to D
Radjawali Distribution -> JF Hillebrand
Duration: 8 mins**, Distance:** 3.3 km

D to E
JF Hillebrand -> Mad Tapper
Duration: 12 mins**, Distance:** 5.9 km

E to F
Mad Tapper -> Wine & Spirits
Duration: 14 mins**, Distance:** 8.9 km

F to G
Wine & Spirits -> East of Avalon
Duration: 5 mins**, Distance:** 1.7 km

…… **to A**



Multiple Vehicle Routing

Case 1

Constraints- No. of Vehicles = 2

Result-

----VEHICLE 1 ROUTE DETAILS-----
Route Segment: 1
Asia Pacific Breweries - to - Eastern Craft
Distance: 15.8 km **Duration:** 18 mins
.
.
.
Route Segment: 4

----VEHICLE 2 ROUTE DETAILS---- **Route Segment: 1**
Asia Pacific Breweries - to - JF Hillebrand
Distance: 24.2 km **Duration:** 26 mins
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.
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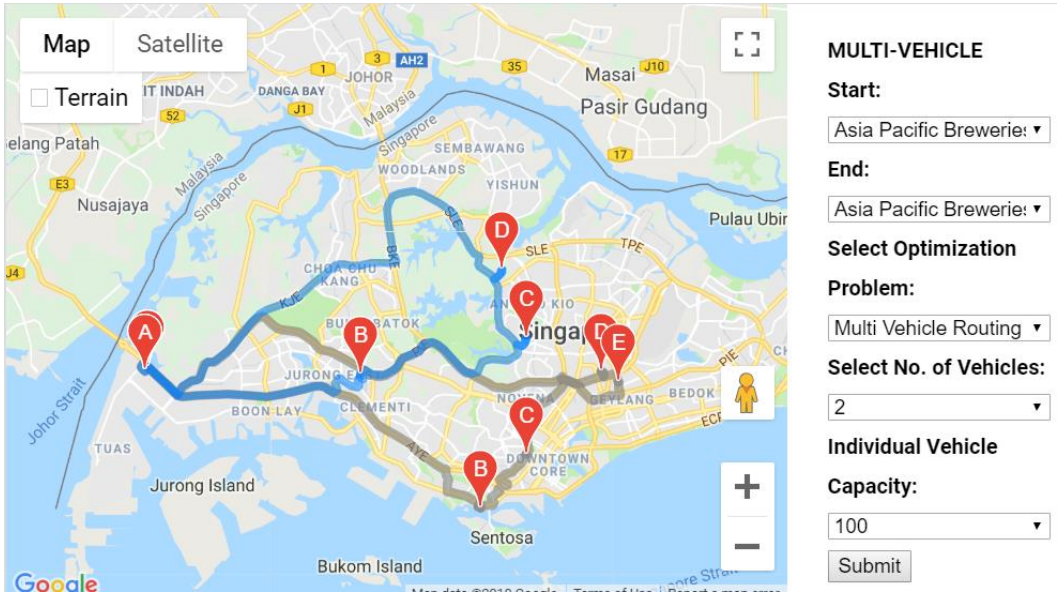
Route Segment: 5

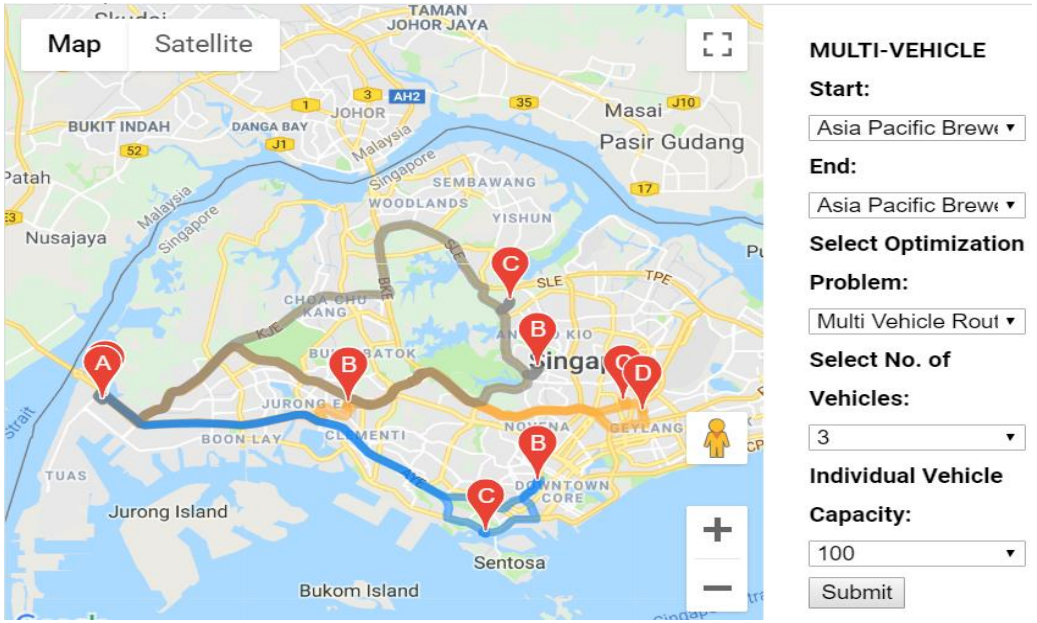


Case 2

Constraints- No. of Vehicles = 3

Result-

------VEHICLE 1 ROUTE DETAILS--------
Route Segment: 1
Asia Pacific Breweries - to - Eastern Craft
Distance: 15.8 km **Duration:** 18 mins
. . . . .
------VEHICLE 2 ROUTE DETAILS-------
. . . . .
------VEHICLE 2 ROUTE DETAILS-------

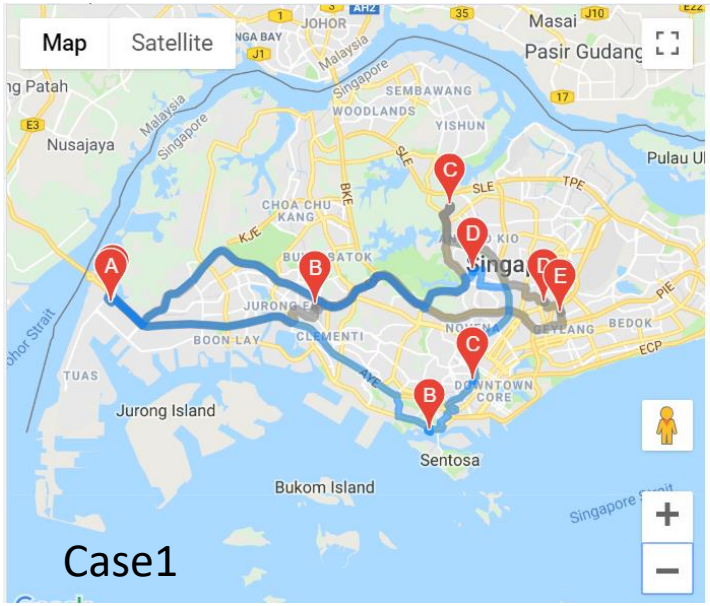


Capacitated VRP

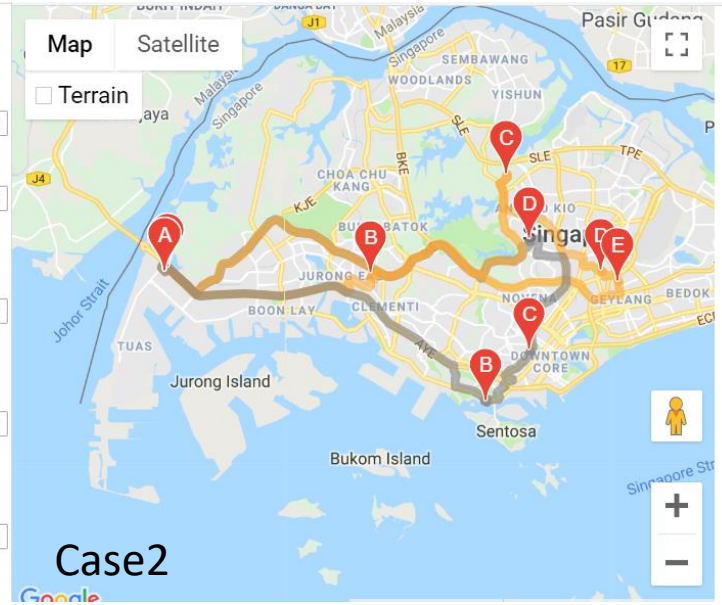
Case 1
No. of Vehicles = 2
Individual Veh. Cap.= 100

Case 2
No. of Vehicles = 3
Individual Veh. Cap.= 100

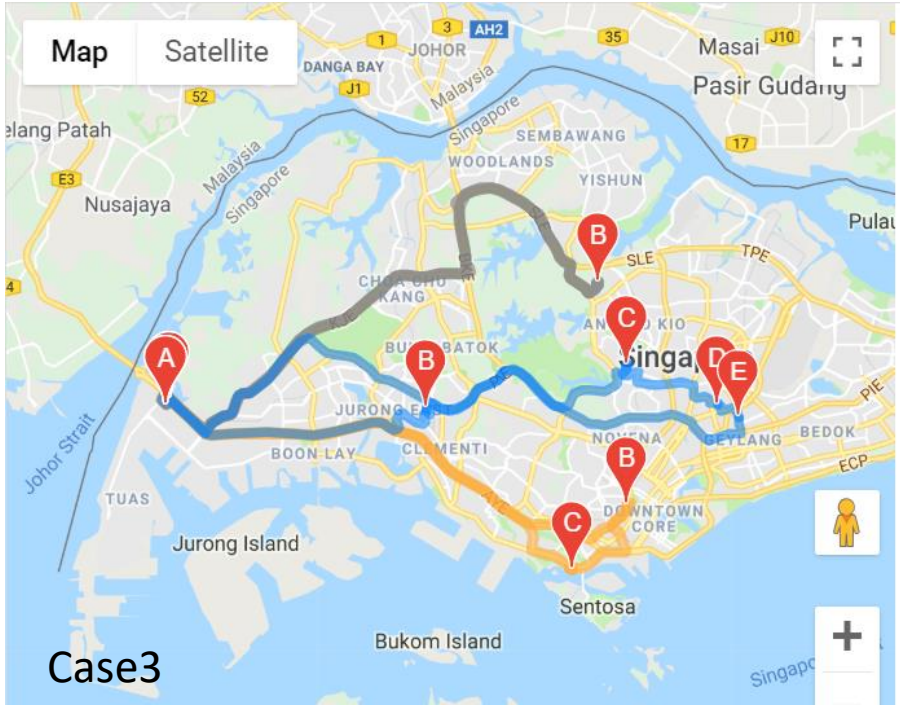
Case 3
No. of Vehicles = 3
Individual Veh. Cap.= 80



MULTI-VEHICLE
Start: Asia Pacific Breweri
End: Asia Pacific Breweri
Select Optimization Problem: Capacitated Vehicle
Select No. of Vehicles: 2
Individual Vehicle Capacity: 100
Submit



MULTI-VEHICLE
Start: Asia Pacific Breweri
End: Asia Pacific Breweri
Select Optimization Problem: Capacitated Vehicle
Select No. of Vehicles: 3
Individual Vehicle Capacity: 100
Submit



MULTI-VEHICLE
Start: Asia Pacific Breweri
End: Asia Pacific Breweri
Select Optimization Problem: Capacitated Vehicle
Select No. of Vehicles: 3
Individual Vehicle Capacity: 80

Result Observed:

- In Case 1 with only 2 vehicles, the route is optimized such that: **Vehicle 1 (80kgs)** + **Vehicle 2 (100kg)**
- In Case 2 with 1 more vehicle the route remains the same: **Vehicle 1 (0kgs)** + **Vehicle 2 (80kgs)** + **Vehicle 3 (100kgs)** since 2 vehicles with 100kg capacity are enough to make all the deliveries.
- In Case 3 after reducing the individual vehicle capacity to 80: **Vehicle 1 (80kgs)** + **Vehicle 2 (40kgs)** + **Vehicle 3 (60kgs)** the additional vehicle now is put to use.

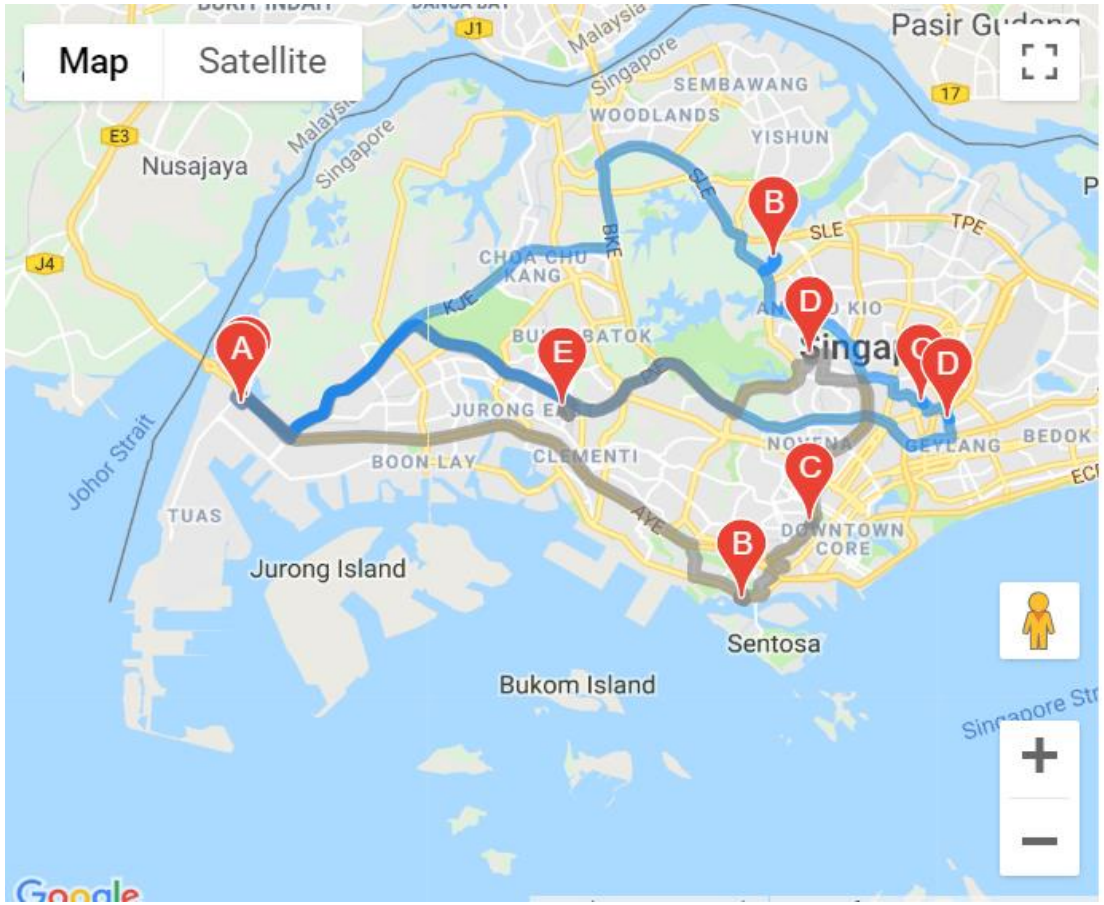
Capacitated VRP with Time Window

Constraints-
No. of Vehicles = 2
Individual Vehicle Cap = 100
Time Window for delivery completion= now to 4.5 h
Unit Unloading time = 2 min

Result-

------VEHICLE 1 ROUTE DETAILS--------
Route Segment: 1
Asia Pacific Breweries - to - Chuan Seng Huat
Distance: 31.9 km
Earliest Delivery Tm: 1817 s **Latest Delivery Tm:** 1937 s
Load Delivered: 40
.
.
Route Segment: 3
Wine & Spirits Distributers - to - East of Aavalon
Distance: 1.7 km
Earliest Delivery Tm: 10588 s **Latest Delivery Tm:** 10719 s
Load Delivered: 30

------VEHICLE 2 ROUTE DETAILS--------
Route Segment: 1
Asia Pacific Breweries - to - JF Hillebrand Beverage Logistics
Distance: 24.2 km
Earliest Delivery Tm: 1586 s **Latest Delivery Tm:** 1686 s
Load Delivered: 50
. . . .



MULTI-VEHICLE

Start:

Asia Pacific Breweri

End:

Asia Pacific Breweri

Select Optimization

Problem:

Capacitated Time W

Submit

Route Segment: 4
Beer Importers & Distributers - to - Eastern Craft
Distance: 13.8 km
Earliest Delivery Tm: 13951 s **Latest Delivery Tm:** 14051 s
Load Delivered: 10

Resultant Observation:

Vehicle 1 last station delivery completion time = 2.9h
Vehicle 2 last station delivery completion time = 3.9h

Proposed Enhancements

- Make the Capacitated VRP with Time Window Routing Solution compatible to receive constraints parameters as input through the WebUI
- Provide provision to accept the individual distribution centre load requirements through the WebUI
- Customize markers to map to display solution information through popups.

KEY CHALLENGES FACED

- Could not update routes as per traffic information due the Google Maps Traffic Request being billed under the Premium Plan of Google Maps API
- Integrating the Optimization Solution with a Display/Rendering Service
    - Google OR-tools Python client
    - Google Maps directions rendering service in Javascript