

Implementation of Vehicle Dispatching and Monitoring in a Self-Driving Delivery Emulation System for Urban Areas

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Unmanned Delivery of Takkyubin



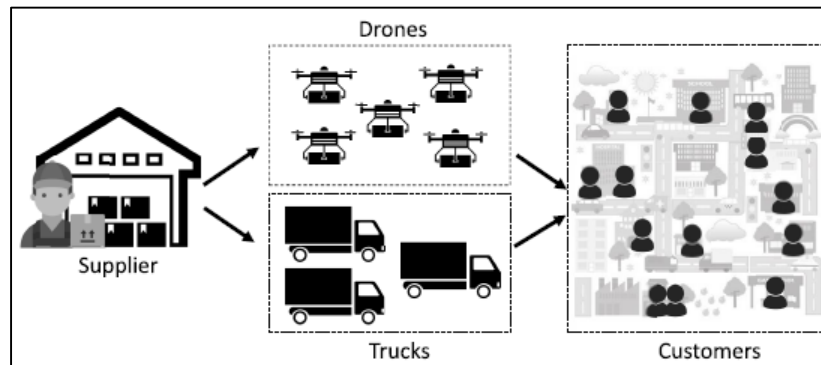
Motivation

1. The **last mile delivery** is one of the most expensive stages of the entire e-logistic chain.
2. In the last mile delivery, the most widespread delivery mode is **home delivery**.
3. In the area of home delivery, there is no complete self-driving delivery system.
4. The thesis develops the software part of a self-driving delivery emulation system.
5. Thus, the self-driving development company can apply the implementation into the actual self-driving cars for achieving the goal of system integration directly.

Related Work- Delivery Modes

	Aerial vehicles [7]	A joint ground and aerial delivery service framework [8]	Cargo bikes [9]	Self-driving Vehicles [11]
Rapidity	◎	△	×	△
Scalability	×	△	×	◎
Reliability	×	◎	△	◎
Computation time	△	×	◎	△

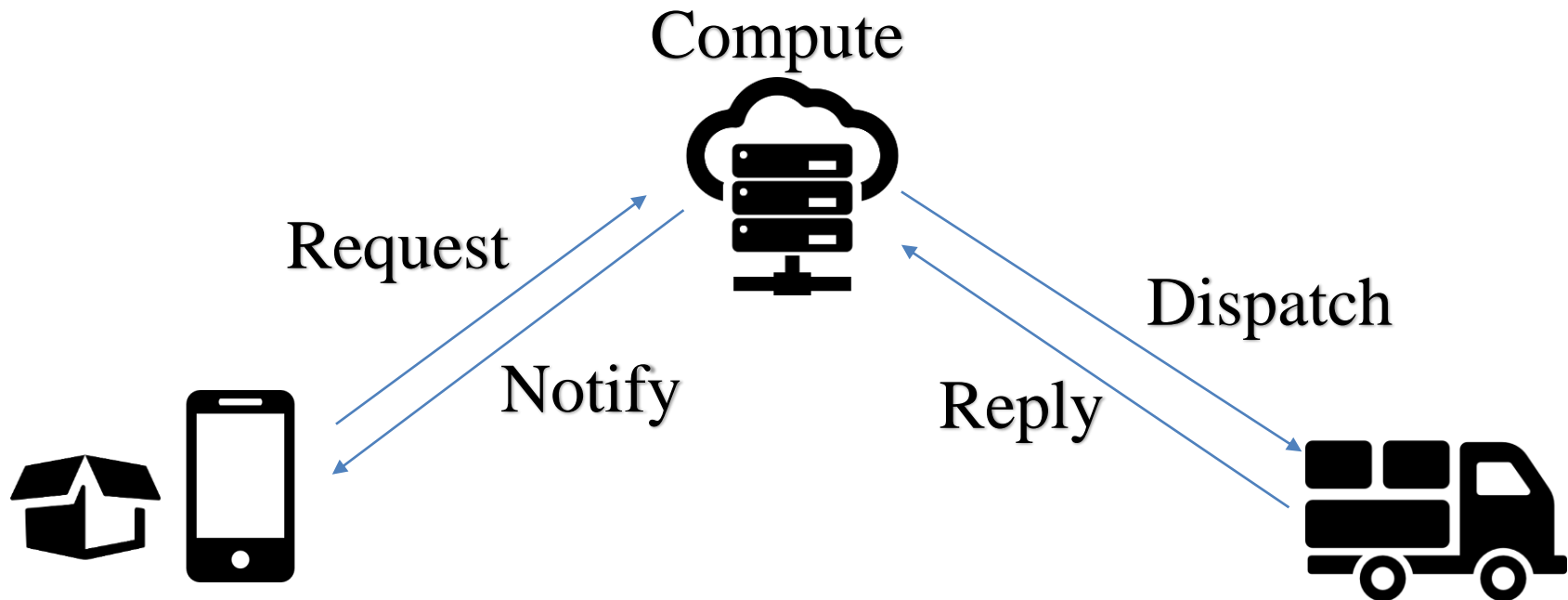
◎ Excellent, △ Ordinary, × Poor



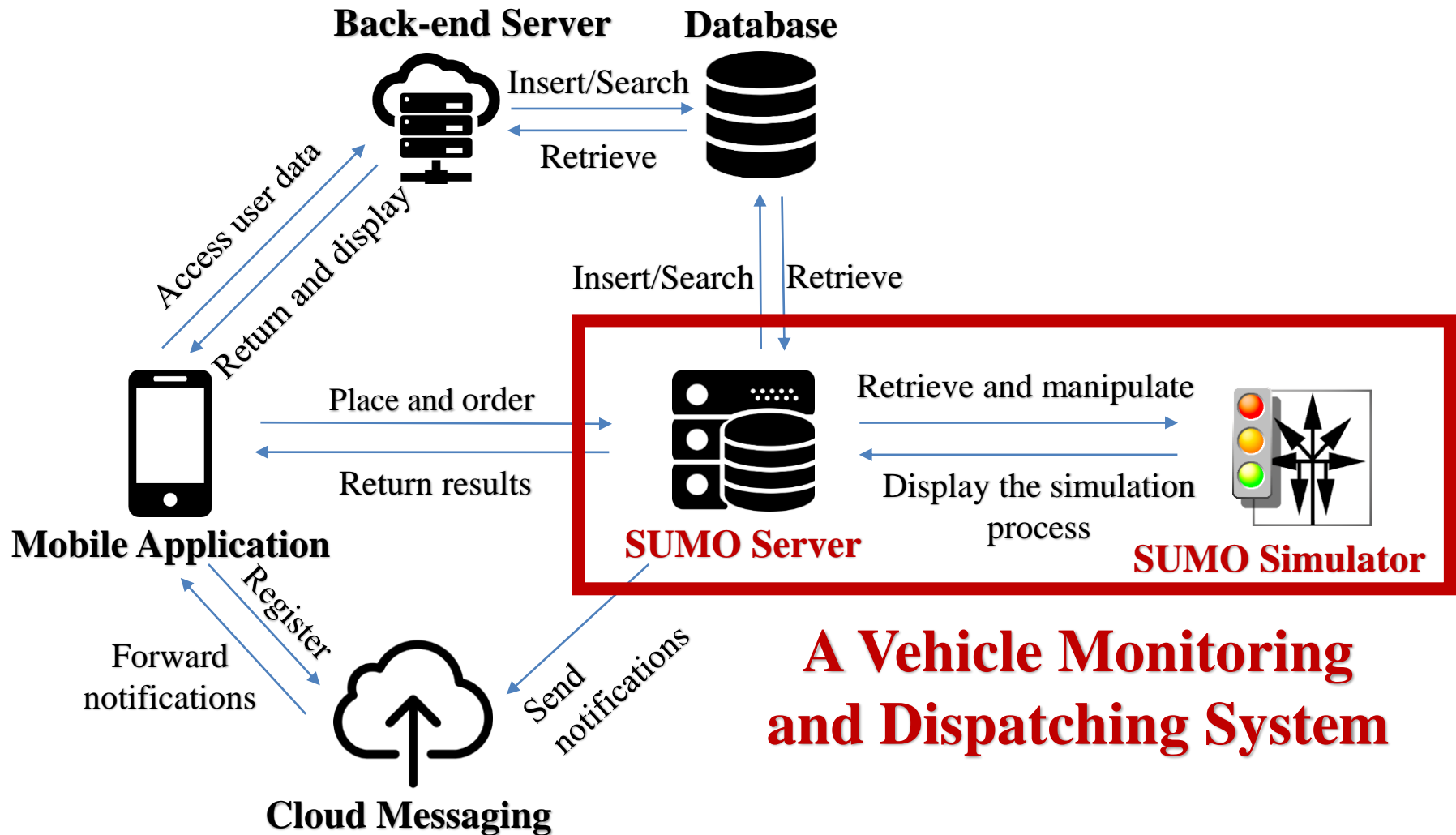
Introduction

1. The thesis implements a **vehicle dispatching and monitoring system** to simulate the parcel delivery process.
2. The system develops a dispatching mechanism to deal with the order requests and arranges the routes dynamically and immediately.
3. This study utilizes the SUMO simulator with the map of the downtown area of Tainan.
4. The simulation is performed with five scenarios of the parcel delivery service.

System Architecture with Self-Driving Truck

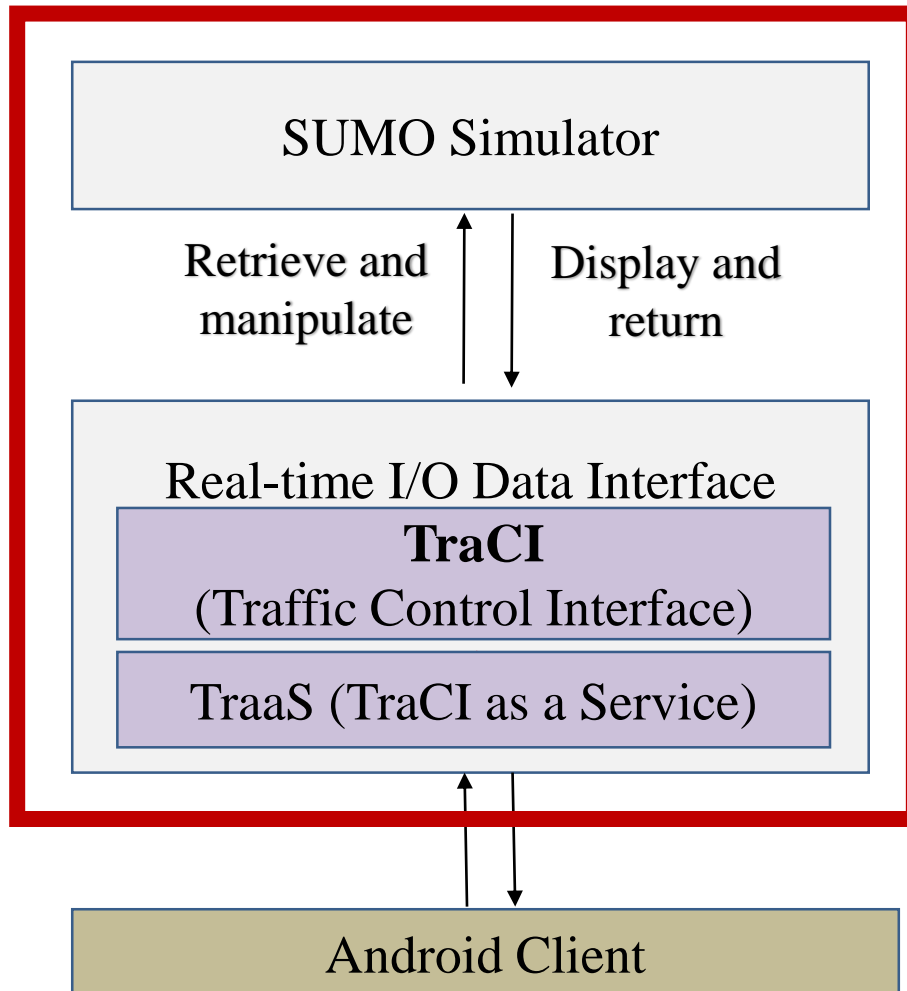


A Whole System Overview



Traffic Control Interface

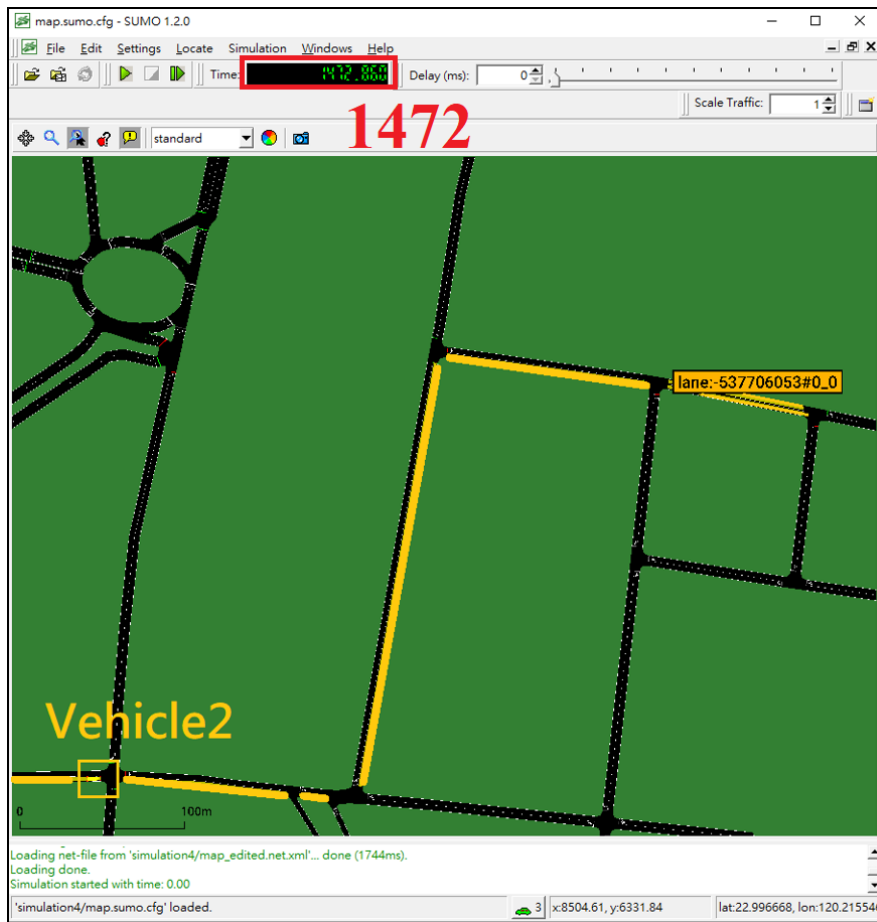
Vehicle Monitoring and Dispatching System



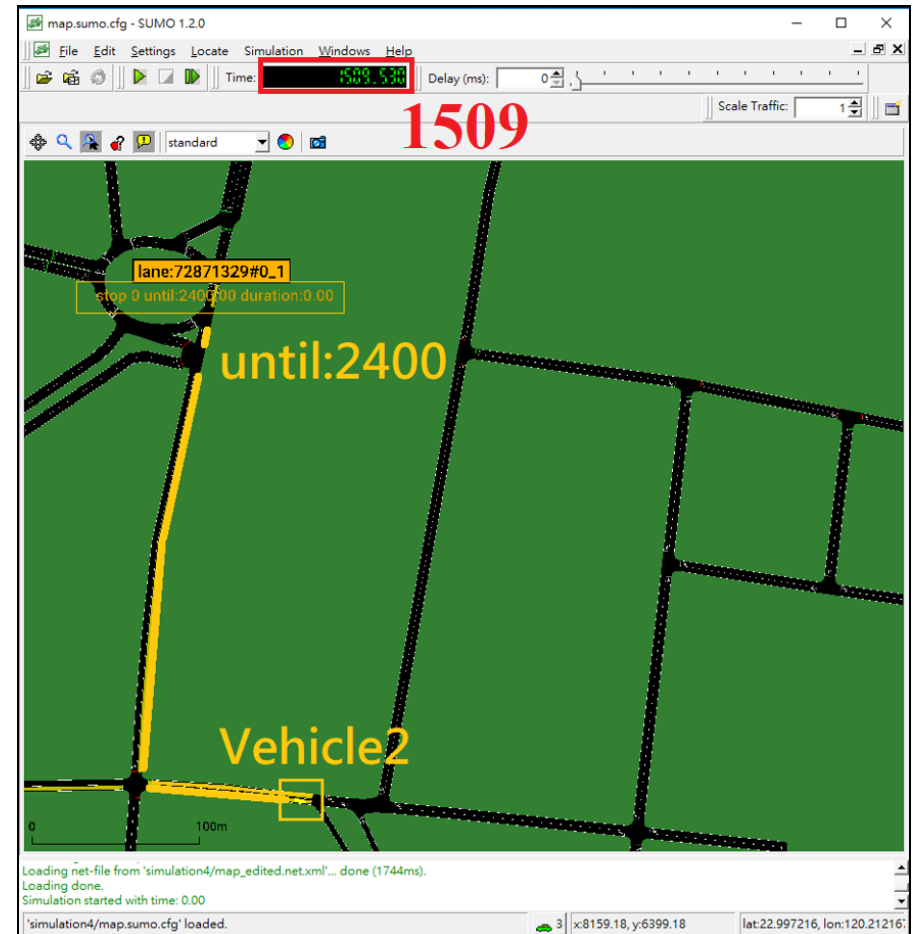
- Real-time I/O Interface communicate between the simulation and the user application bi-directionally.
- TraCI retrieves the values of vehicles and manipulates their behaviors.
- The service binds on a specific IP address with a specific port.
- TraaS communicates with the Android Client.

Manipulation of Vehicle Routing

Before

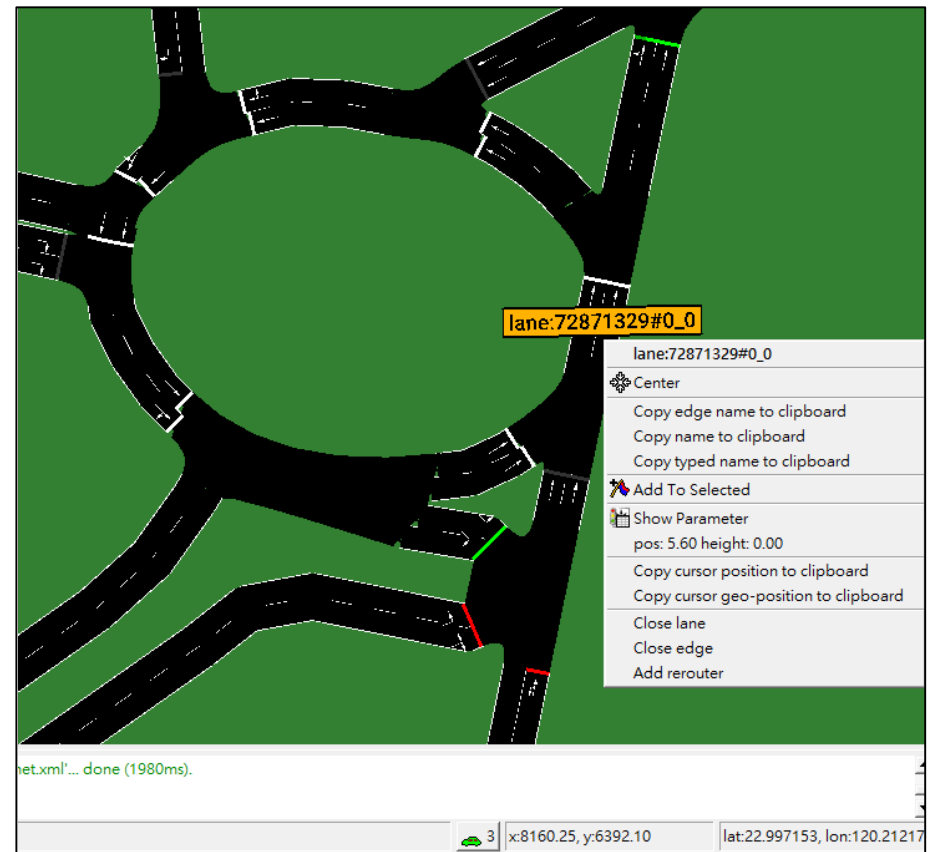


After

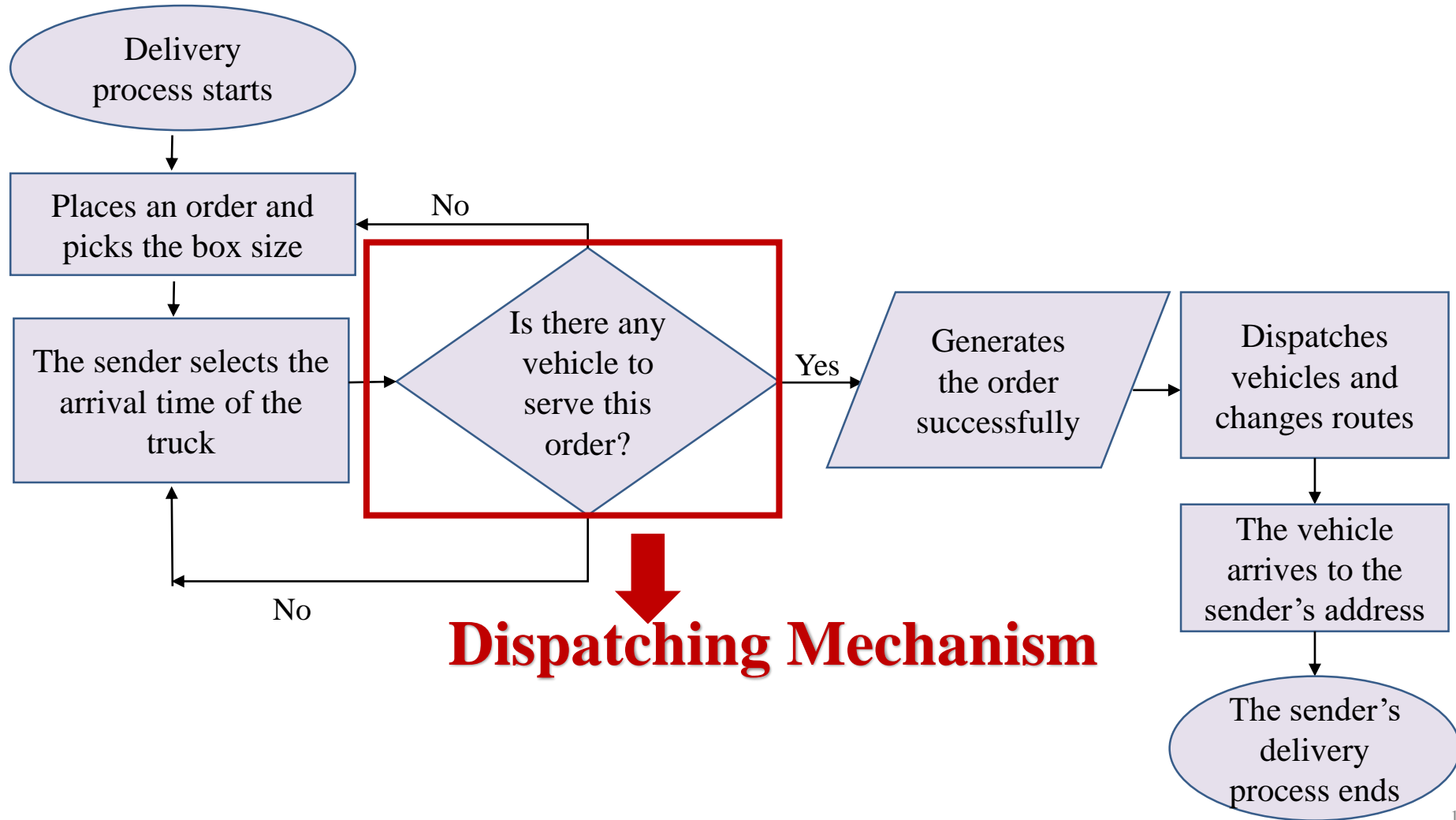


Map Address Conversion

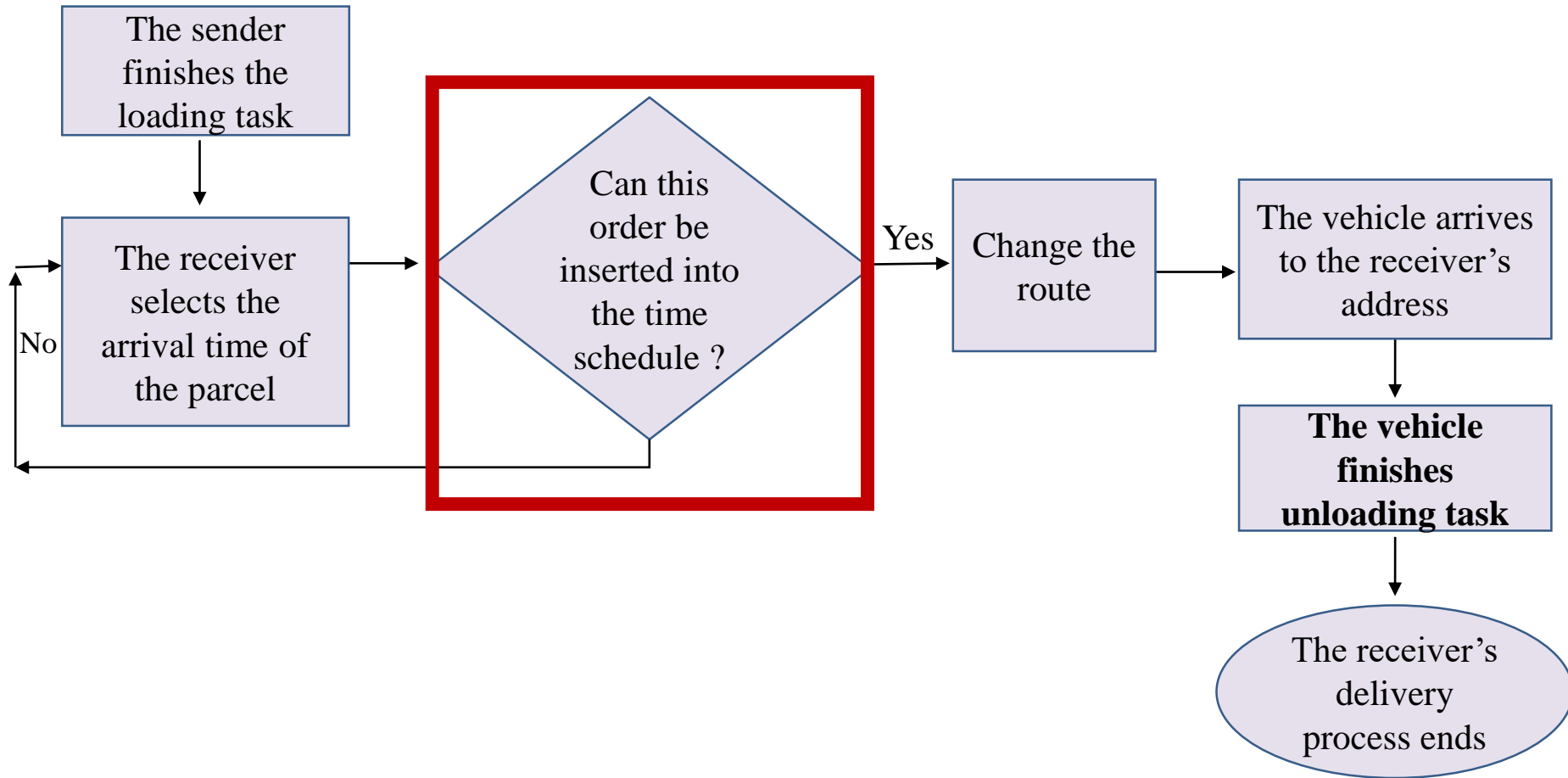
Sender address **Google Map API** → longitude, latitude → **convertRoad function in SUMO API** → Road ID of SUMO



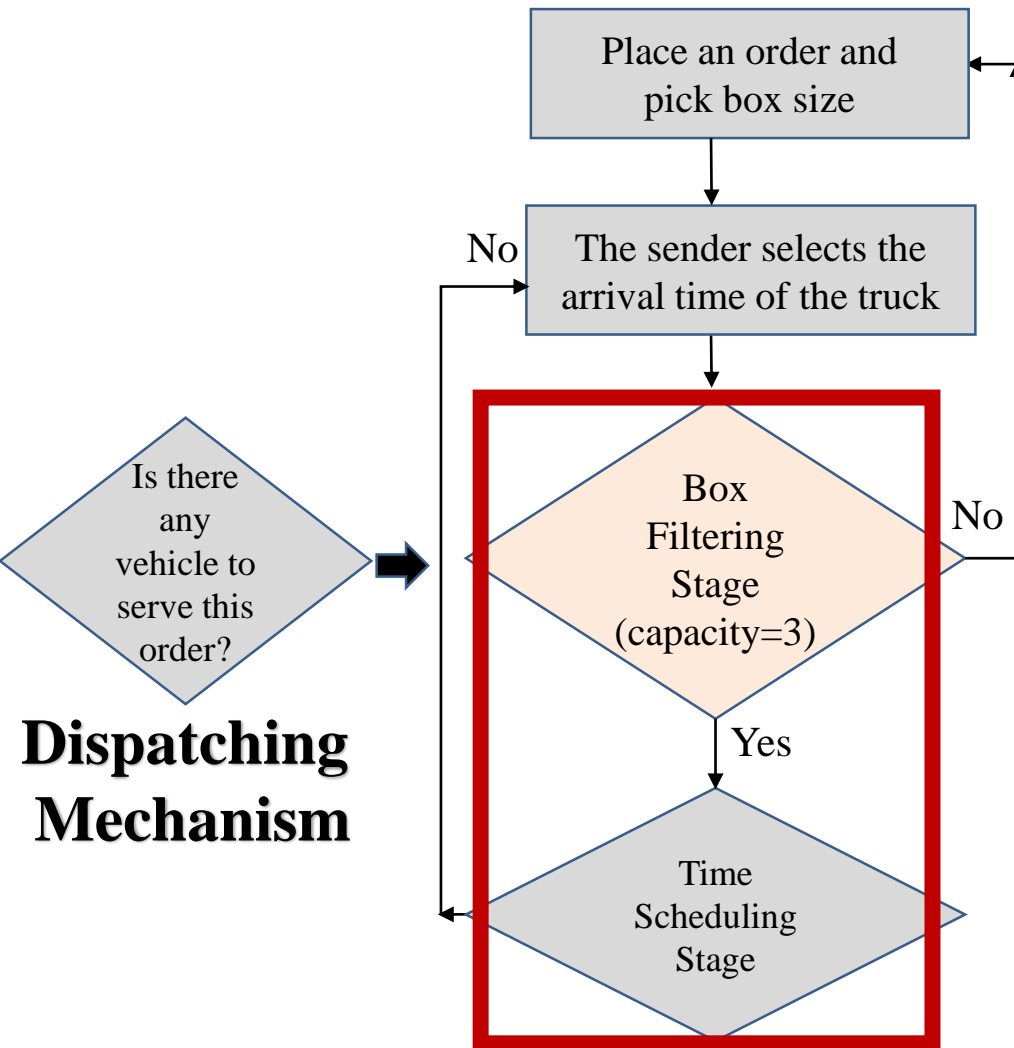
Flow Chart of Parcel Delivery Process in Sender's Part



Flow Chart of Parcel Delivery Process in Receiver's Part



Dispatching Mechanism



211

Vehicle ID Small size Container number

	V1	V2	V3
small	111 112		
medium		221	
large			

After the small box insertion,
v1,v2 and v3 exists

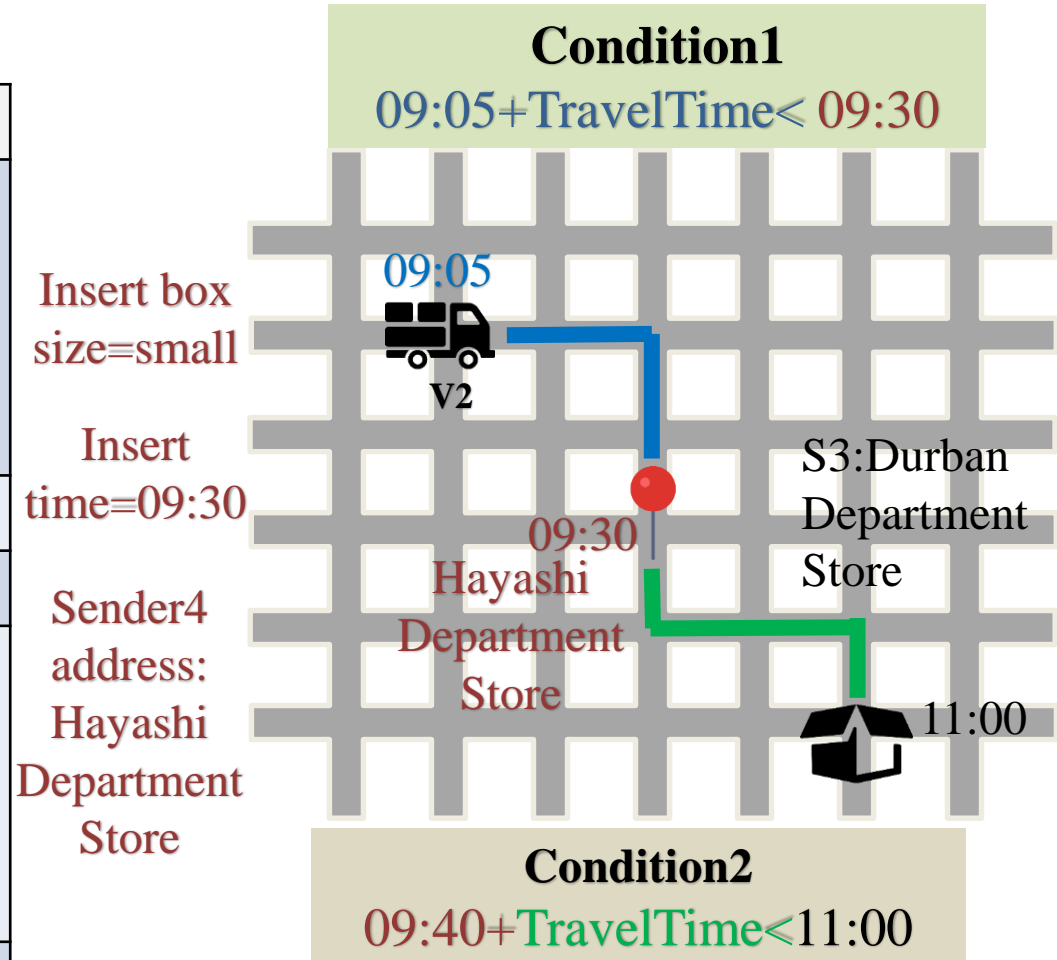
	V1	V2	V3	V4	V5
small	111				
medium	121 122 123	221	321 322 323	421 422	
large					

After the medium box insertion,
v2, v4 and v5 exists

Case One: Simple Time Scheduling Stage (1)

Current Time=09:05

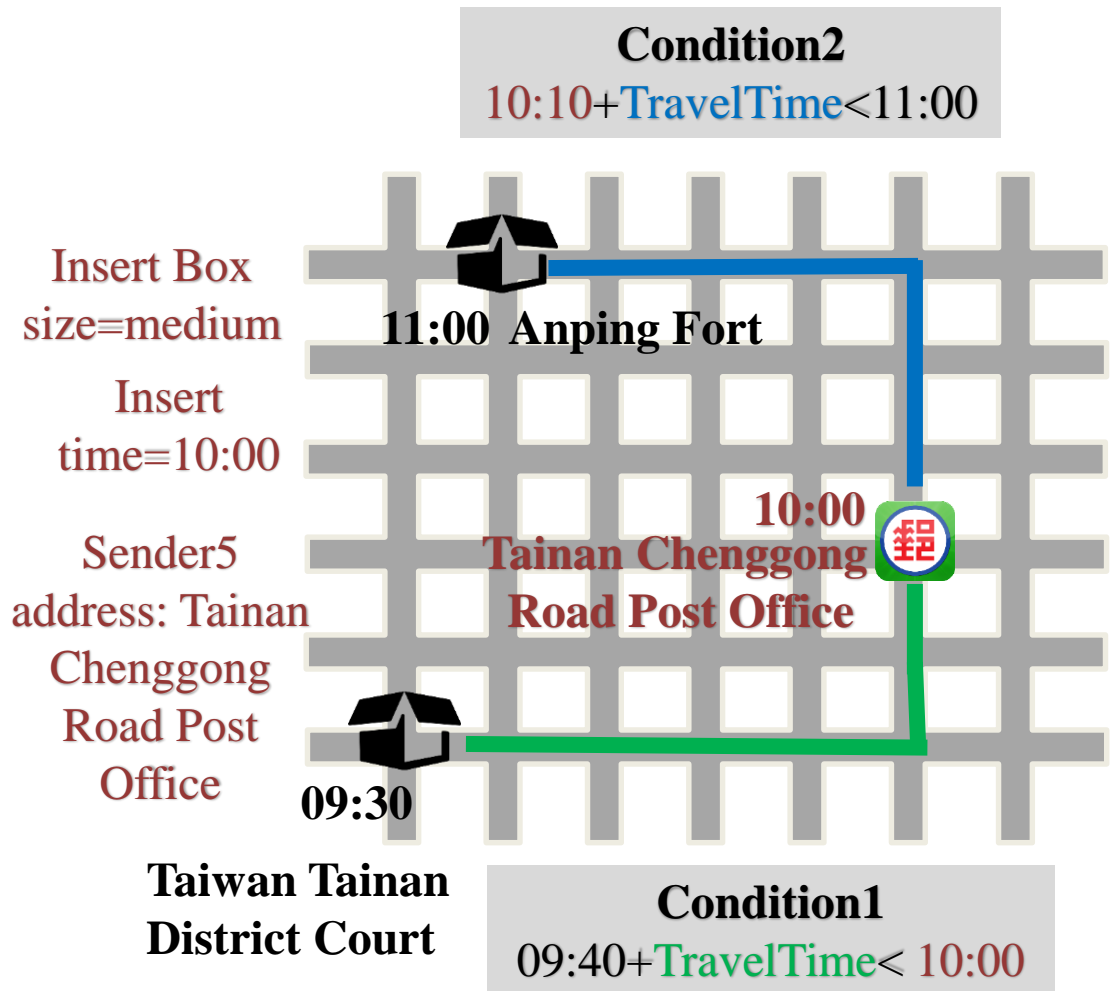
	V1	V2	V3
09:30	S1:Taiwan Tainan District Court, small(111)		
10:00			
10:30			
11:00	S2:Anping Fort, small(112)	S3:Durban Department Store, medium (221)	
11:30			



Case Two: Simple Time Scheduling Stage (2)

Current Time:09:15

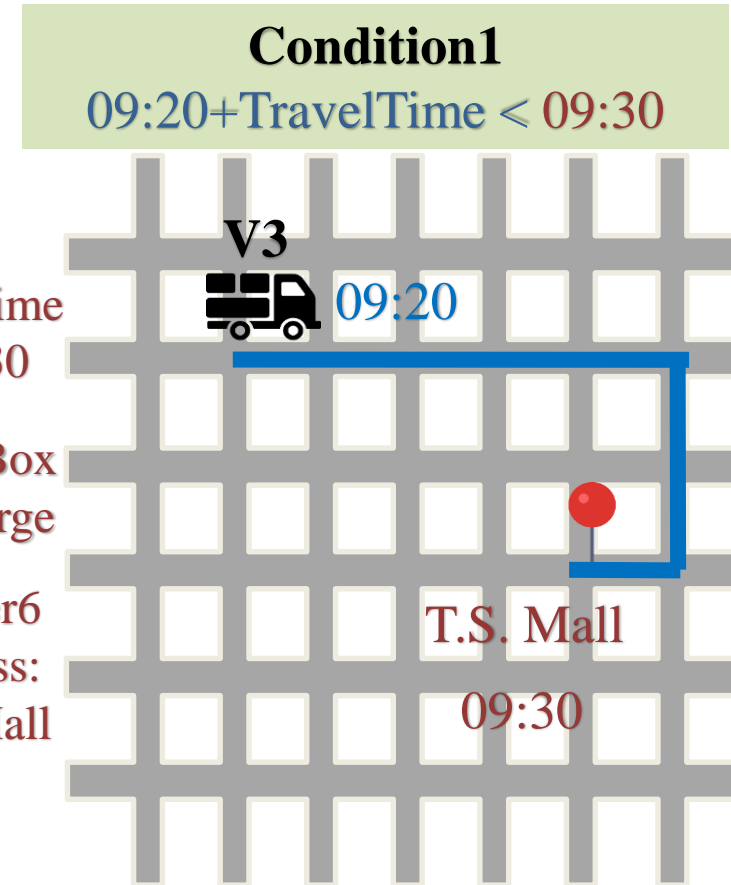
	V1	V2	V3
09:30	S1:Taiwan Tainan District Court, small(111)	S4:Hayashi Department Store, small (211)	
10:00			
10:30			
11:00	S2:Anping Fort, Small (112)	S3:Durban Department Store, medium (221)	
11:30			



Case Three: Simple Time Scheduling Stage (3)

Current Time:09:20

	V1	V2	V3
09:30	S1:Taiwan Tainan District Court, small (111)	S4:Hayashi Department Store, small (211)	
10:00	S5:Tainan Chenggong Road Post Office, medium (121)		
10:30			
11:00	S2:Anping Fort, small (112)	S3:Durban Department Store, medium (221)	
11:30			



Sender Scenario

Time	V2
09:30	S4:Hayashi Department Store
10:00	
10:30	
11:00	S3:Durban Department Store
11:30	

Current Time:09:25



Coming Notification
(09:25)

Arriving Notification
(09:30)

Finish Loading Process
(09:35)

Ending Parking
(09:40)

Receiver Scenario (1)

Time	V2
09:30	S4:Hayashi Department Store
10:00	R4:National Cheng Kung University Hospital
10:30	
11:00	S3:Durban Department Store
11:30	



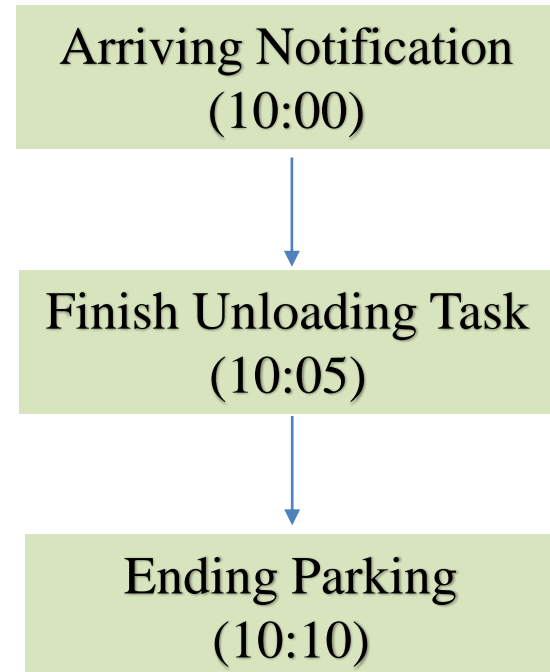
Receiver 4 selects the arrival time of the parcel at 09:37.

Vehicle 2 forwards to the receiver's address at 09:40.

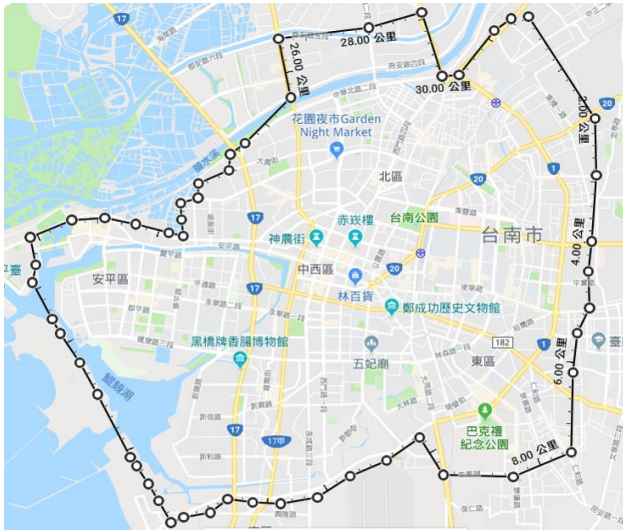
Receiver 4 gets the coming notification 09:55.

Receiver Scenario (2)

Time	V2
09:30	S4:Hayashi Department Store
10:00	R4:National Cheng Kung University Hospital
10:30	
11:00	S3:Durban Department Store
11:30	

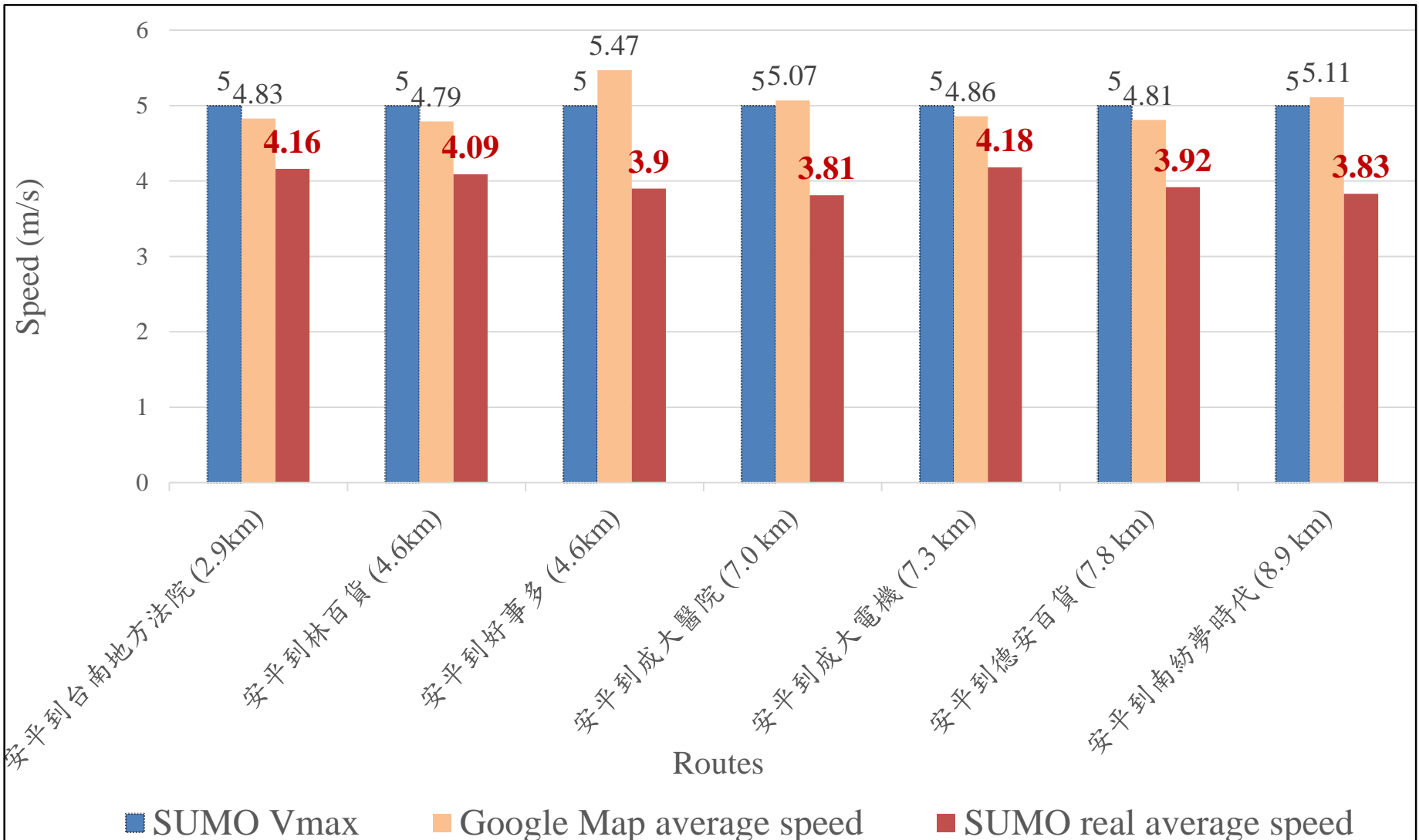


Parameters of Simulation



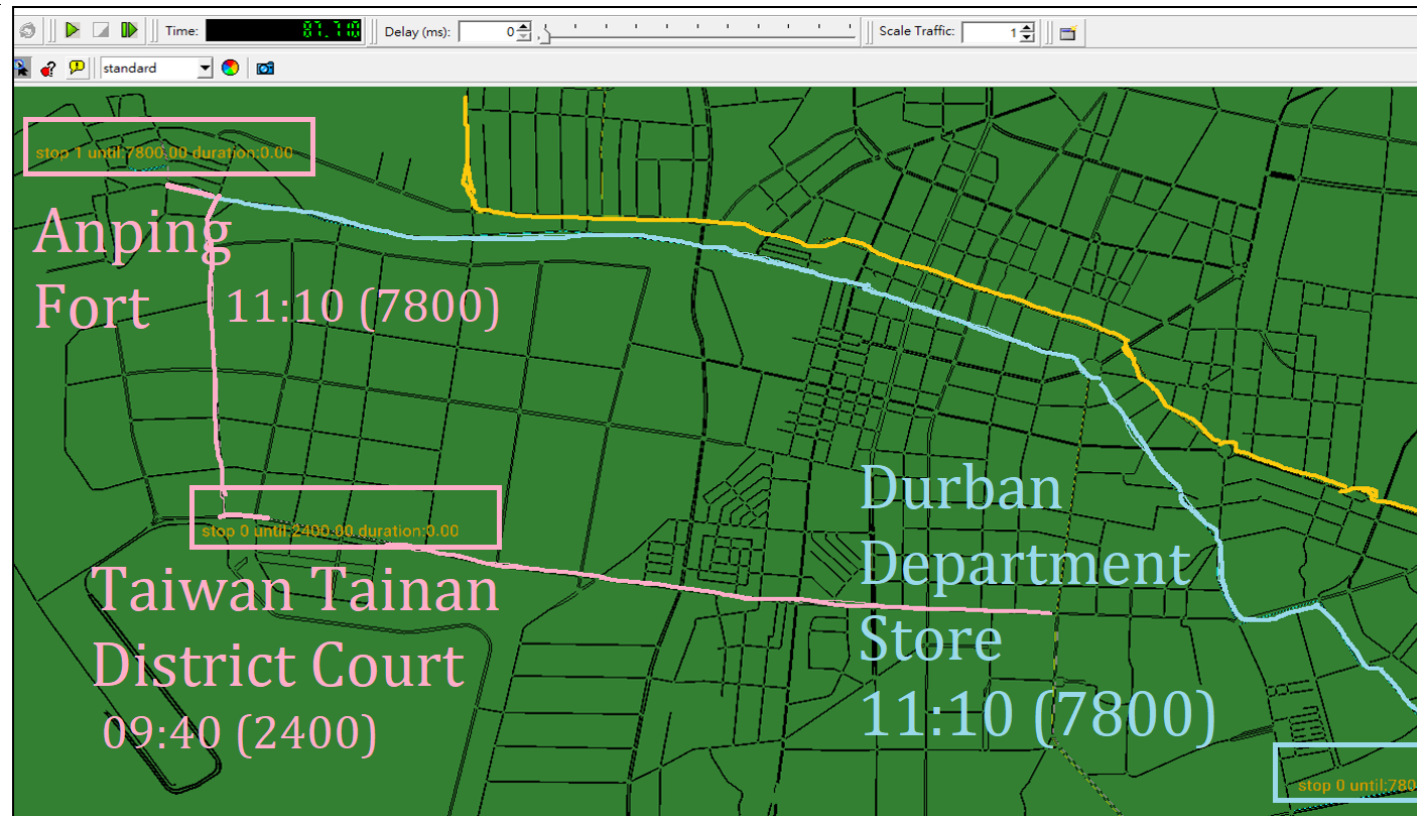
Parameters	Value
Simulation area	50.07 km ²
The number of junctions	6785
The number of roads	25069
The number of trucks	3
Vmax	5.0 [m/s]=18 km/hr
Average speed of truck	3.8 [m/s]=13.68 km/hr
Simulation time	09:00~15:00 (6 hours=21600 seconds)

Average Vehicle Speed Estimation



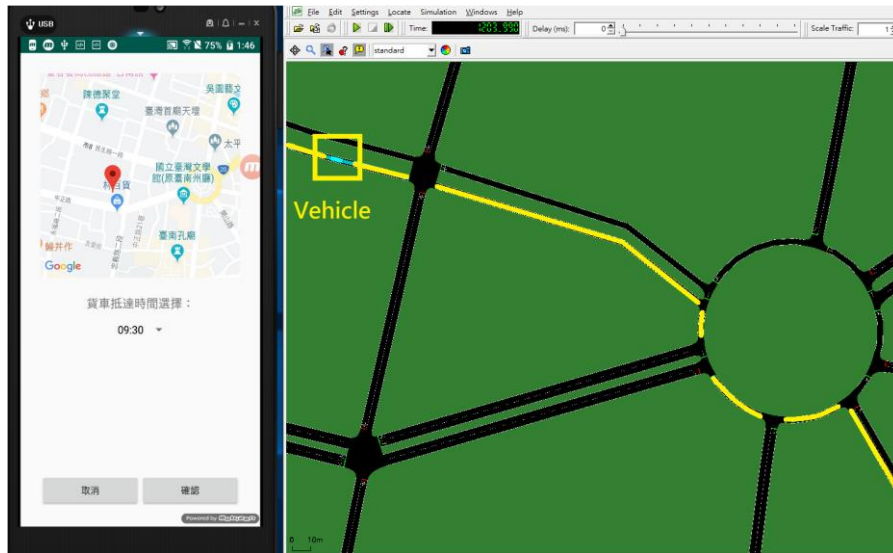
Simulation Result- Initialization

Time	V1	V2	V3
09:30	S1: Taiwan Tainan District Court		
10:00			
10:30			
11:00	S2: Anping Fort	S3: Durban Depart- ment Store	
11:30			

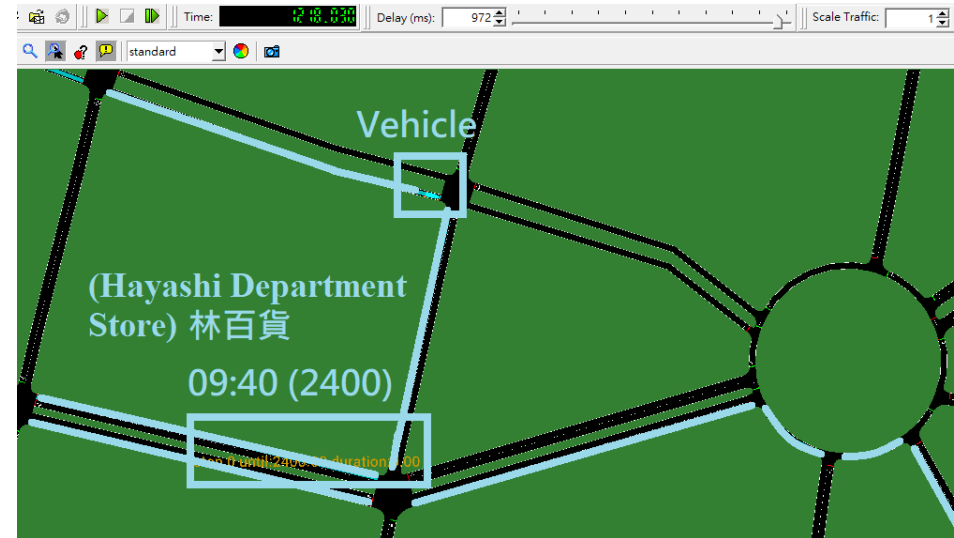


Simulation Result- Sender Request

Current Timeseconds:1203
(09:20:03)



Current Timeseconds:1218
(09:20:18)



Simulation Result- Loading Process

Current Timeseonds:2104 (09:35)

Receiver's phone

沒有 SIM 卡 88% 3:10

6月16日, 週日

● AV_Delivery_v1.0 • 29分鐘 ^ **09:35**

貨物已上車
寄件人已將貨物寄出, 請到我的貨物可選擇收貨時間。

Mobizen Mirroring • 1小時
Mobizen Mirroring
這端連接DESKTOP-K585QIA和USB

設定
將 USB 用於
檔案傳輸

媒體儲存
已視為媒體裝置連線
將媒體檔案傳輸至電腦

Android 系統
已連接 USB 偵錯工具
輕觸即可停用 USB 偵錯。

全部清除

Powered by **CityEngine**

map.sumo.cfg - SUMO 1.2.0

File Edit Settings Locate Simulation Windows Help

Time: 2:04.5:00 Delay (ms): 0 Scale Traffic: 1

standard

Vehicle2 at 林百貨 (Hayashi Department Store)

stopped since 2:04:00 duration 2:05:35

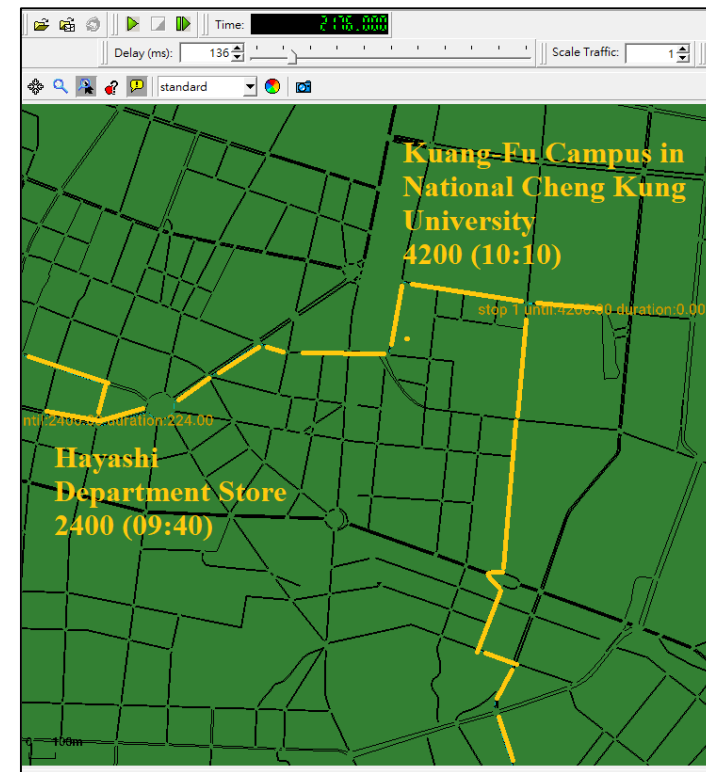
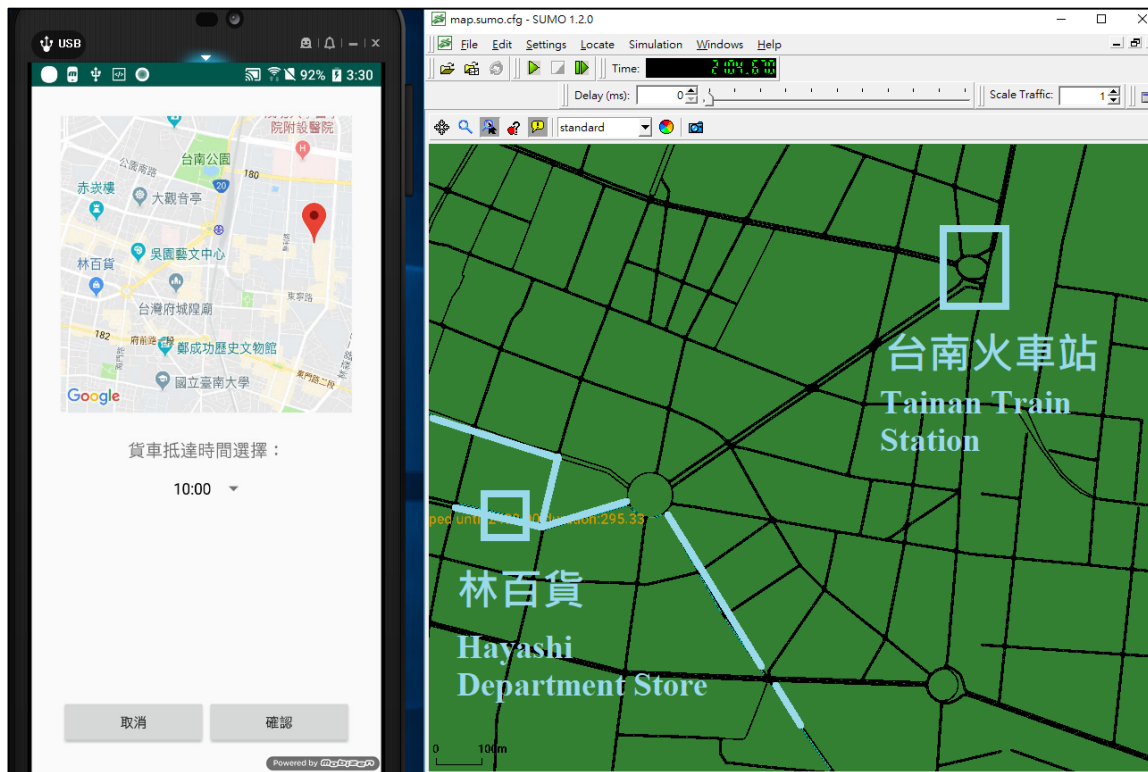
vehicle:2 Parameter

Name	Value	Dynamic
param:211	1	×
param:212	0	×
param:213	0	×
param:221	1	×
param:222	0	×
param:223	0	×
param:231	0	×
param:232	0	×
param:233	0	×

Simulation Result- Receiver Request

Current Timeseconds:2104
(09:35:04)

Current Timeseconds:2176
(09:36:16)



Simulation Result- Unloading Process

沒有 SIM 卡 100% 4:06

6月16日, 週日

10:00

● AV_Delivery_v1.0 • 2分鐘
貨車已到達
貨物已送達, 請準備簽收。

● AV_Delivery_v1.0 • 2分鐘
貨車即將到達
貨車將於約5分後到達。

Mobizen Mirroring • 2小時
Mobizen Mirroring
遠端連接DESKTOP-K585QIA和USB

設定
將 USB 用於
檔案傳輸

媒體儲存
已視為媒體裝置連線
將媒體檔案傳輸至電腦

全部清除

Powered by Mobizen

map.sumo.cfg - SUMO 1.2.0

4069 (10:07:49)

Time: 4069.0 3400 4069.0 3400 Delay (ms): 0 Scale Traffic: 1

The vehicle 2 would not leave until 4200 (10:10).

stopped until 4200.00 duration:130.66

The parcel was unloaded.

Name	Value	Dynamic
param:211	0	X
param:212	0	X
param:213	0	X
param:221	1	X
param:222	0	X
param:223	0	X
param:231	0	X
param:232	0	X
param:233	0	X

0 10m

Conclusion

- 1.The study implemented a vehicle dispatching and monitoring system to simulate the package delivery process.
- 2.This system used Traffic Control Interface to manipulate the vehicle's behavior and retrieve values in SUMO simulator.
- 3.With the proposed dispatching mechanism, the system can detect whether the order is established.
- 4.The simulation result showed the whole parcel delivery process with the parking scenario.

Future Work

Scalability: The system would be used in larger map and have more trucks into different areas according to the number of parcels.

Quantity: The system has to deal with a larger batch of orders in a brief period of time in the future.

Accuracy: The accuracy of the estimated vehicle speed should be measured by the real-time road conditions.