For office use only	Team Control Number	For office use only
T1 ________	**77281**	F1 ________
T2 ________		F2 ________
T3 ________	Problem Chosen	F3 ________
T4 ________	**D**	F4 ________

2018
MCM/ICM
Summary Sheet

The LaTeX Template for MCM Version v6.2

Summary

This paper mainly focuses on the two aspects of location and convenience to formulate relevant policies to support the full adoption of electric vehicles.

We compare The Super Charger and Destiny Charger. With the data of location of each charger and its stalls number, we plot the Voronoi Map, which shows the super charger stations spread alone the USA highway and big citys.

We search the data of USA EV number and charger number,and plot those numbers and their rate. We find that Tesla is on track to allow a complete switch to all-electric in the US.

Nowadays, there emerge various high-tech transportation modes such as car-share and ride-share services, self-driving cars, rapid battery-swap stations for electric cars, and even flying cars and a Hyper-loop.They will accelarate the speed of EV devolpment by changing the charging time,reduce the price we will pay, promot the speed we gain,and so on.

Keywords: Electric Vehicals; Charging Station Location

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February 12, 2018

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1 Introduction

With the rapid development of the automobile industry, the problems caused by automobiles such as environmental pollution and energy shortage have become increasingly prominent. In order to maintain the sustainable development of the national economy and protect the human living environment and energy supply, electric vehicles are gradually being favored by people for their environmental protection performance.

However, the migration from gasoline and diesel cars to electric vehicles is not simple and can't happen overnight. The challenge is how to design the distribution of charging stations, knowing that location and convenience are crucial to early adopters' feelings and whether they can become mainstream.

Therefore, this paper mainly focuses on the two aspects of location and convenience to formulate relevant policies to support the full adoption of electric vehicles.

Here are the compare of Super Charger and Destiny Charger:

	Super Charger	Destiny Charger
cost	1000k	50k
price	1.8RMB/kWh	1.0RMB/kWh
time	30min 1.5h	6h
method	FAST	SLOW

Table 1: Compare

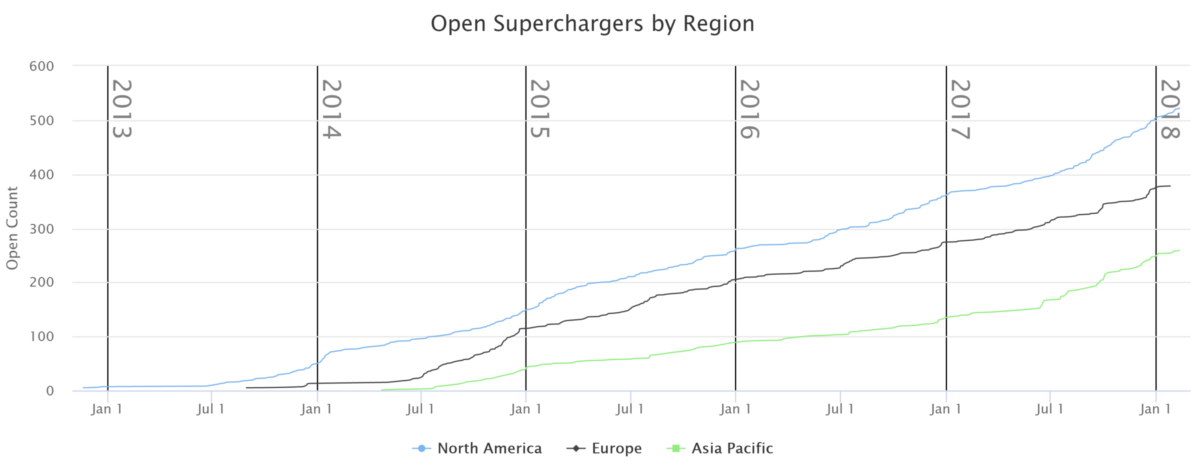

Figure 1: Open Superchargers By Regions

2 Analysis of the Problem

2.1 Location Model

Let's consider such a transportation network, in which each electric vehicle is driven from a starting point to a destination. Due to the limits of its maximum battery capac-

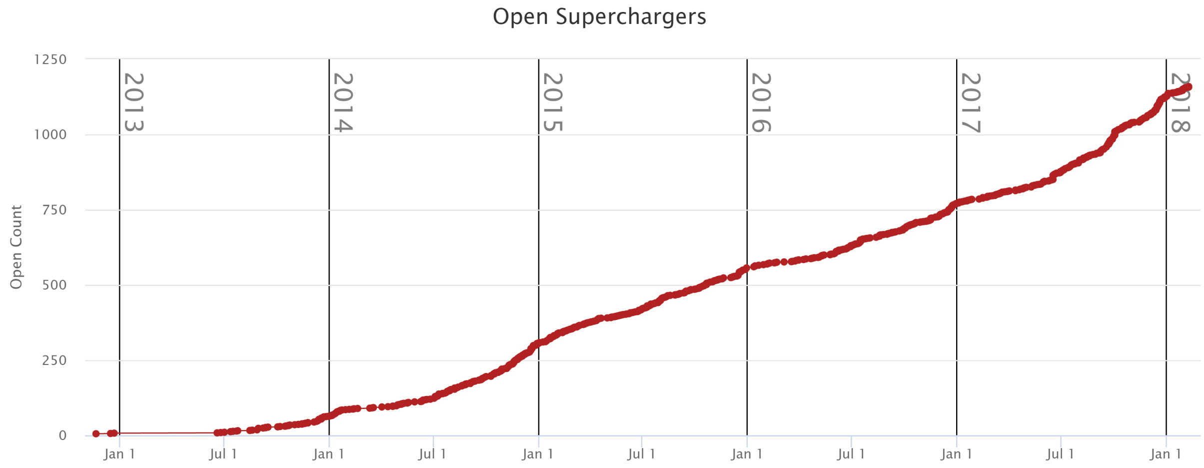

Figure 2: Open Superchargers

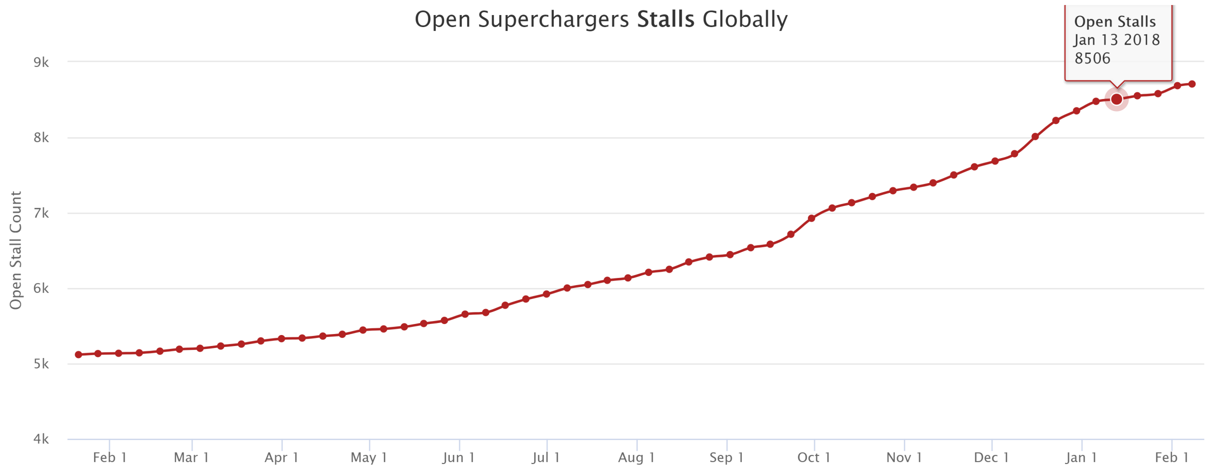

Figure 3: Open Superchargers Stall Globally

ity and mileage, vehicles must be charged on the way, or it canâĂŹt finish the whole trip. It is necessary to build sufficient charging stations on the road to meet charging requirements. This article introduces a new factor , the service capacity, which refers to the amount of electricity one station can provide within a day. In this article, service capacity is divided into two parts, which are divided into the number of charged piles and the electricity distribution of a charging station.

Our model meets the following conditions. First, the vehicle reaches the destination along the shortest route of the road. Second, the maximum driving range of a vehicle is a constant number; The electric power dissipation and filling capacity of the vehicle has a linear relationship with the driving distance. Third, the car is not required to be fully charged, as long as the whole trip can be completed. Each motor vehicle can start with a half of the total charge.

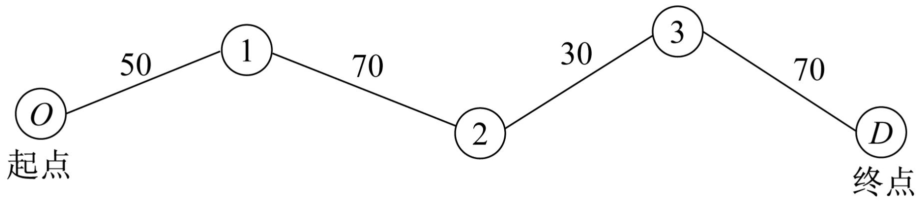

Figure 4: O-D Model

3 Task 1

First, let's explore the current U.S. Tesla charging network. Tesla currently offers two types of charging stations

- destination charging designed for charging for several hours at a time or even overnight.
- supercharging designed for longer road trips to provide up to 170 miles of range in as little as 30 minutes of charging.

In order to study whether Tesla is on an all-electric road, we use matlab to get the following figure based on the relevant database.

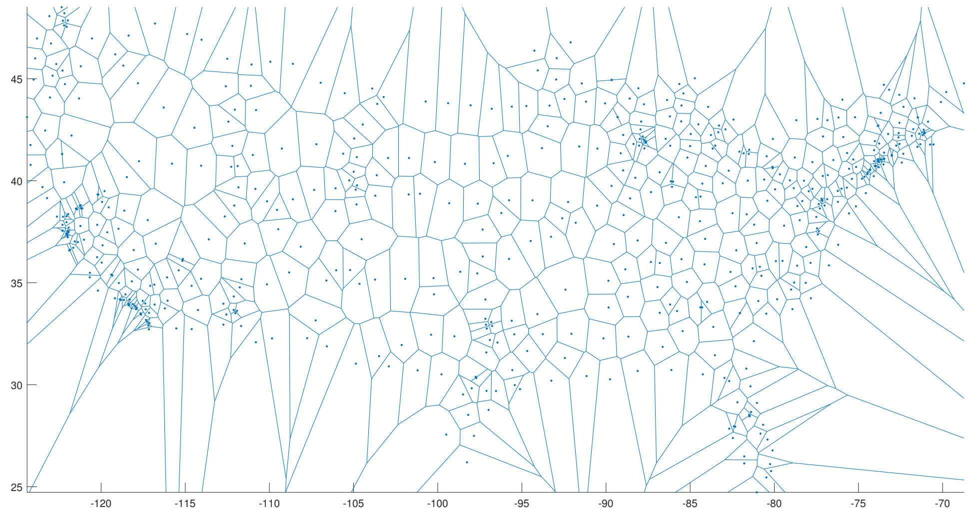

Figure 5: USA Voronoi Map

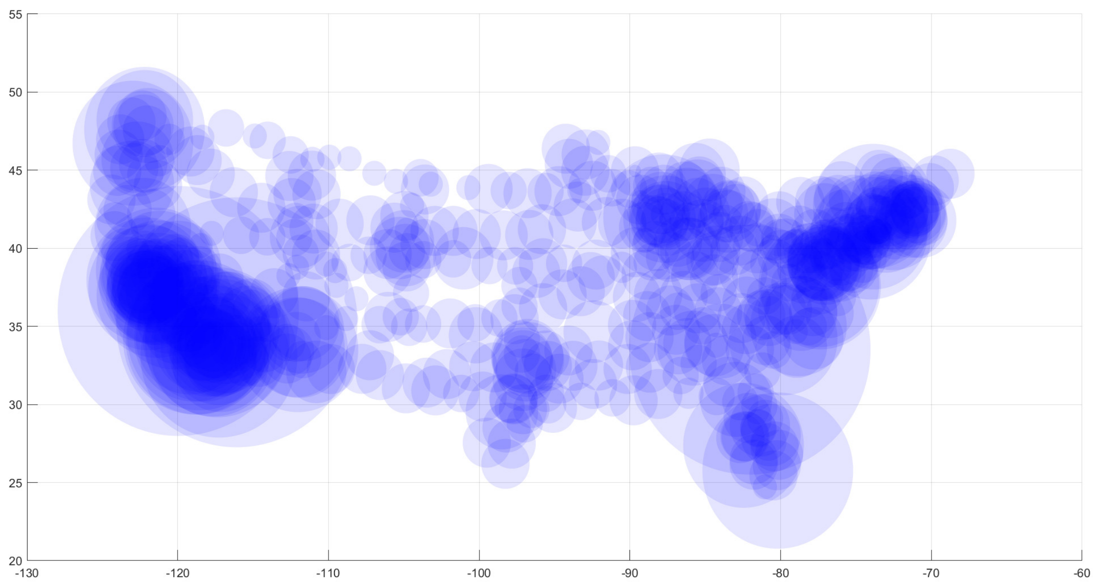

Figure 6: USA Circular Map

In our understanding, this issue mainly involves two angles:

- Comparison of vehicle sales and electric vehicle growth
- The changes of Charging pile number whether can keep up with the sales of vehicles

It can be seen from the trend of two curves that the number of charging poles can keep up with the number of electric vehicles.

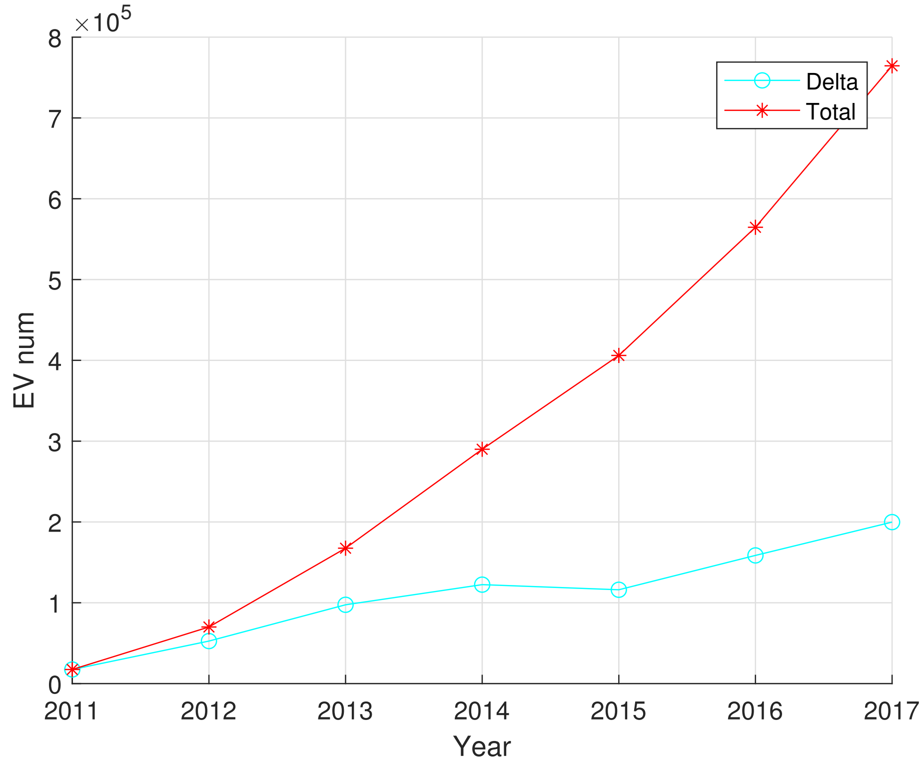

Figure 7: EVnum

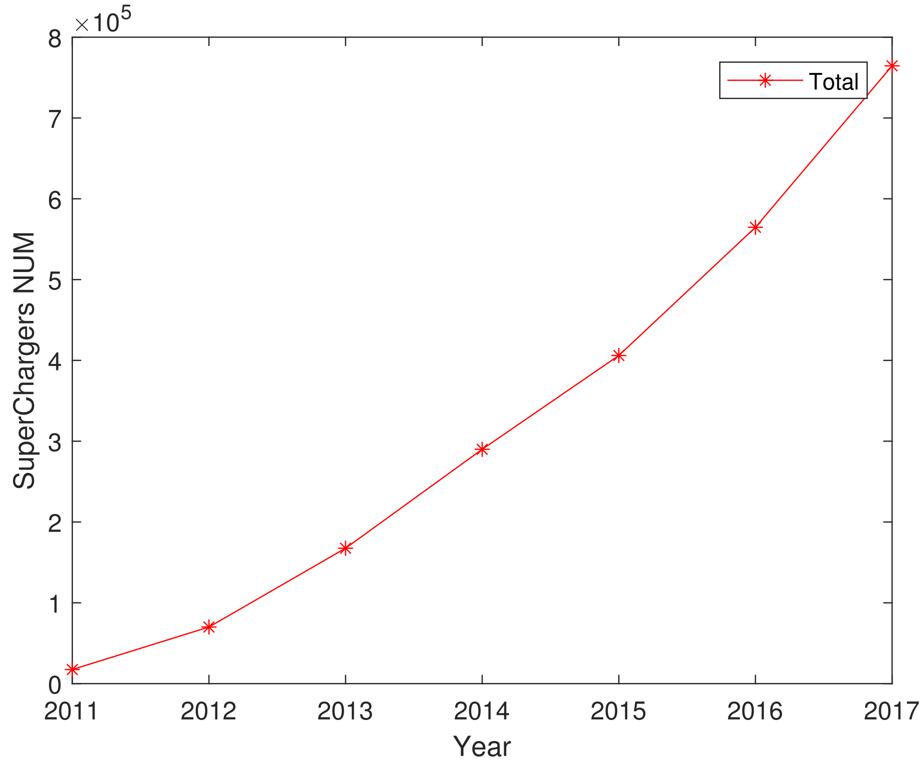

Figure 8: Super chargers

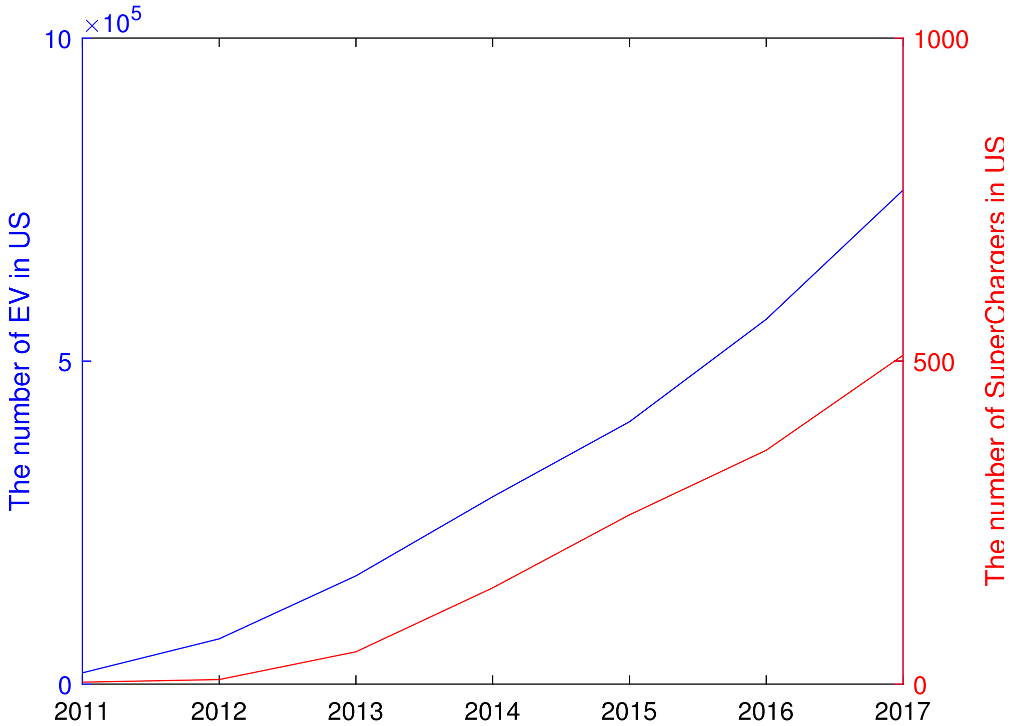

Figure 9: EV and Chargers

4 Task 2

5 Task 3

6 Task 4

Nowadays, there emerge various high-tech transportation modes such as car-share and ride-share services, self-driving cars, rapid battery-swap stations for electric cars, and even flying cars and a Hyper-loop.

The car-pooling service matches up car owners who are willing to offer a ride with those needing a lift, in the hope of making trips to their destination more convenient and cost-effective.Driver-less vehicles free driverâĂŹs hands and concentration.

Battery-swap stations for EV give rise to a more favourable charging experience. Flying cars take full advantage of space and together with Hyper-loops, it shortens travel time tremendously.

Moreover, all of these technologies serving as alternatives to traditional transportation contribute to a superior allocation of transportation resources, alleviate the strain on public transport plus environment, and promote the transformation of global energy structure.

EVTOL (electric vertical take-off and landing aircraft) as the most promising solution for flying cars is faster than the EV. The EVTOL's demand of power is also very high. As more and more EVOTLs used, grid load will increase rapidly, we will need more powerful electric grid.In some big city that will be very crowd , EVTOL may take the place of EV.

Hyperloop is much more faster than any vehical we have nowadays, people will spend less time when travalling long distance, Hyperloop may play the role of train rather than the car. Also Hyperloop will use solarpower , personally, we think Hyperloop will have little affect on EV.

Car-share and ride-share services will reduce the price we pay. Rapid battery-swap stations for electric cars will facilitate people's lives. They will accelarate the speed of EV devolpment.

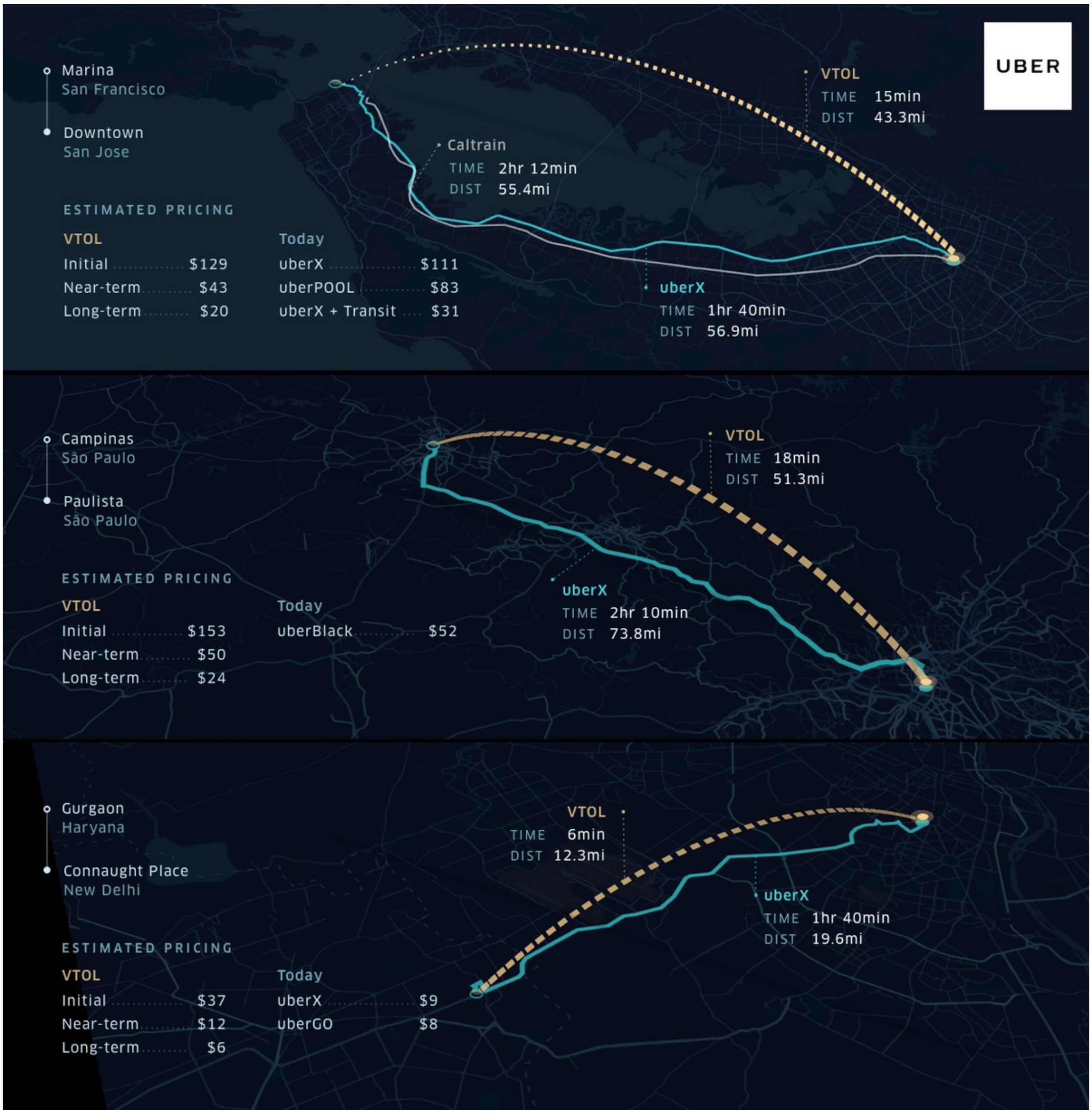

Figure 10: EVTOL taxis and normal taxis

7 Task 5

8 The Model Results

9 Validating the Model

10 Conclusions

11 A Summary

12 Evaluate of the Mode

13 Strengths and weaknesses

13.1 Strengths

- **Applies widely**
  This system can be used for many types of airplanes, and it also solves the interference during the procedure of the boarding airplane,as described above we can get to the optimization boarding time.We also know that all the service is automate.
- **Improve the quality of the airport service**
  Balancing the cost of the cost and the benefit, it will bring in more convenient for airport and passengers.It also saves many human resources for the airline.
-

References

[1] D. E. KNUTH The TEXbook the American Mathematical Society and Addison-Wesley Publishing Company , 1984-1986.

[2] Lamport, Leslie, LATEX: " A Document Preparation System ", Addison-Wesley Publishing Company, 1986.

[3] https://supercharge.info/

[4] https://insideevsforum.com/

Appendices

Appendix A First appendix

Here are simulation programmes we used in our model as follow.

Input matlab source:

```
a = [17425 , 52607 , 97507 ,122438 , 116099 , 158614 , 199826];
b = cumsum(a);
s = [3,7,50,149,262,362,509];
x=1:7;

[AX,H1,H2] = plotyy(x,b,x,s,'plot');

set(AX(1),'XColor','k','YColor','b');
set(AX(2),'XColor','k','YColor','r');

HH1=get(AX(1),'Ylabel');
set(HH1,'String','The number of EV in US');
set(HH1,'color','b');

HH2=get(AX(2),'Ylabel');
set(HH2,'String','The number of SuperChargers in US');
set(HH2,'color','r');

set(H1,'LineStyle','-');
set(H1,'color','b');
set(H2,'LineStyle','-');
set(H2,'color','r');

set(gca,'xtick',[1:7]);
set(gca,'xticklabel',['2011';'2012';'2013';'2014';'2015';'2016';'2017'])
```

Input matlab source:

```
a = [17425 , 52607 , 97507 ,122438 , 116099 , 158614 , 199826];
b = cumsum(a);
hold on;
grid on;
plot(a,'c-o');
x=1:7;
ylabel('EV num');
xlabel('Year');
plot(x,b,'r-*');
hold off;
set(gca,'xtick',[1:7]);
set(gca,'xticklabel',['2011';'2012';'2013';'2014';'2015';'2016';'2017'])
legend('Delta','Total');
```

Here is the Rate simulation:

Input matlab source:

```
% Rate
a = [17425 , 52607 , 97507 ,122438 , 116099 , 158614 , 199826];
```

```
b = cumsum(a);
s = [3,7,50,149,262,362,509];
x=1:7;
c=zeros(1,7);
for p = 1:7
    c(p)= s(p) / b(p);
end

hold on;
plot(x,c,'r-*');
ylabel('SuperChargers RATE');
xlabel('Year');
set(gca,'xtick',[1:7]);
set(gca,'xticklabel',['2011';'2012';'2013';'2014';'2015';'2016';'2017'])
legend('Total');
hold off;
```

Appendix B The Voronoi Code And The Circle Code

Input matlab source:

```
Y = xlsread('LocationUSA.xlsx','A1:A549');
X = xlsread('LocationUSA.xlsx','B1:B549');
Z = xlsread('USA.xlsx','G2:G550');
hold on;


voronoi(X,Y);

xlim([min(X) max(X)])
ylim([min(Y) max(Y)])

[vx,vy] = voronoi(X,Y);
[v,c] = voronoin([X(:) Y(:)]);
%plot(vx,vy,'.','markersize',9);
%scatplot(vx,vy)
hold off;
```

Input matlab source:

```
Y = xlsread('LocationUSA.xlsx','A1:A549');
X = xlsread('LocationUSA.xlsx','B1:B549');
Z = xlsread('USA.xlsx','G2:G550');   %The number of stalls each station
hold on;
for t = 1:549
    x0 = X(t);
    y0 = Y(t);
    r = Z(t)/5;
    d=0:360;
    x=r*cosd(d);
    y=r*sind(d);
    patch(x+x0,y+y0,'b','edgecolor','none','facealpha',0.1);%šżÍÿÃœűÈ0.15

end

%axis equal
grid on
```

```
%axis off;
set(gcf,'color','w');
```